[ESTABLISHED 1832]

THE OLDEST RAILROAD JOURNAL IN THE WORLD

AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE, INC.

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J. S. BONSALL, Vice-President and General Manager

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Editors:

E. A. AVERILL. R. H. ROGERS

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714 Schiller Bldg., Chicago

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THE LIGHT UNDER A BUSHEL

It is to be deeply regretted that the discussions which should have followed the presentation of reports to the International Railway Congress during its recent Eighth Session in Berne, Switzerland, were, in the majority of instances, exceedingly limited, and may be said to have practically failed in their recognized object to verify or disprove the views advanced by the various able reporters. In consequence, it is found that the conclusions in many of the reports were given immediate acceptance by the Congress, and without any spirited attempt by the presiding officers of sections to open an argument, or to obtain any dissenting views.

This unfortunate condition was particularly in evidence following the presentation of the papers on water tube boilers, superheaters, and high speed locomotives. These were probably the liveliest subjects before the Congress, and of universal interest, hence it was hoped that through the array of undisputed authorities who were present much valuable information would result from their consideration. It appears, however, that the attitude evinced was to accept these papers without comment, in view probably of the prominence of their authors, and in concession to the mastery which they undoubtedly possess over the subject assigned to them for report.

The reporters were requested not to present their reports in length, and to confine merely to their general conclusions. This arose, no doubt, from the assumption that all reports had received a preliminary reading by the delegates interested in the particular questions, but there is room for considerable doubt in regard to their perusal. This being the case, it became impossible to discuss them intelligently from the conclusions alone, without knowledge of upon what they are based.

It is very unfortunate that the laborious and painstaking work of the eminent reporters to the Congress does not receive at least a reasonable circulation in the railroad world and among those whom it might advantage most. The apathetic attitude of the delegates at the session, however, finds its reflection among the motive power heads of almost every country. A copy of the monthly bulletin of the International Railway Congress seldom leaves the office of the mechanical superintendent, and it is no exaggeration to say that two-thirds of his master mechanics never even saw one.

We said that this was unfortunate because these reports are veritable mines of information. They are prepared by carefully chosen men who know whereof they speak, and are not beyond the comprehension of any one sufficiently intellectual to hold a supervising position. We were impressed by the sterling work of Messrs. Vaughn and Noltein in connection with the general review of the locomotive boiler, and that of Messrs. Garstang and Courtin in the portrayal of high speed locomotives of the world. Months were consumed in the preparation of these reports, and the information embodied therein is invaluable to anyone directly interested in this development.

Nevertheless, we fear that this has been labor to little avail unless it is desired that the reports shall be restricted to the narrow confines of a circulation limited by the office of a department head on one end, and that of the editorial office of a technical publication on the other. It is not believed that such is the intent of the International Railway Congress, but it still remains as a painful truth. Corrective measures are, of course, without the province of the Congress, and they resolve into a problem for solution by the superintendent of motive power on his own road, and dependent upon the importance which he attaches to the matter.

At the present time there is more uniformity in design and in the consideration of certain features of maintenance and operation between the various countries than ever exhibited before, and the necessity for an understanding of what is being done elsewhere under practically the same conditions is becoming more and more of a value which cannot be disputed. It is believed that the free circulation of these invaluable reports will

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exert a broadening influence and instill a spirit of tolerance among designers of the different countries where now appears to be largely unfounded criticism, and it is much to be desired that this end may shortly become realized.

TEST OF LOCOMOTIVE FIRE BOXES

In connection with a description of the low water test of the Jacobs-Schupert fire box, which appeared on page 401 of the October, 1910, issue of this journal, it was stated that this test checked the one made a number of years ago by the Pennsylvania Railroad, in showing that there was no danger of explosion by putting cold water on to fire box sheets which had been over-heated. Of course, because of the entire difference in the design and construction of the two fire boxes, this statement meant that this test checked the former one only so far as showing that there was no danger of a sudden cracking or rupture of a fire box sheet heated to a high temperature when cold feed water is injected into the boiler, and also that there was no danger of a sudden very large increase in the steam pressure caused by the hot sheets evaporating the water very rapidly as they were immersed.

Both of these points have been matters of lively discussion at various times and still occasionally are brought up for argument. This test on the Jacobs-Schupert fire box, it would seem, checks the opinions of the best informed engineers on these particular features, although, of course, it must be remembered that the novel construction of this boiler makes it impossible to say that the ordinary fire box would act in the same way, so far as the sheets cracking are concerned, and of course, since this construction employs no staybolts, it is very positive that the stay supported sheet under the same severe treatment would have let go.

The tests mentioned as being made on the Pennsylvania Railroad a number of years ago have been used as a basis of argument on this subject many times, but there seems to be little general knowledge as to the conditions and methods of making them. They were conducted on Oct. 7, 1868, at Kittanning (Horseshoe Curve), near Altoona, with engine No. 99, which was built in March, 1854. This locomotive had a straight boiler, 49 in. in diameter; 25 in. combustion chamber, copper fire box and flues 2½ in. in diameter, and carried a steam pressure of 90 lbs. A steam gauge with a very large dial, visible at a distance, was installed on the locomotive and a steam fire engine, stationed a safe distance away, was connected to the boiler by a 3 in. hose attached to the feed pipe. The engine was fired up and the blower put on, a pressure of 90 lbs. being obtained. The pops were allowed to blow, and the gauge cocks were specially fitted at various levels below the crown sheet and left opened. In about 20 minutes steam came out of the cock located 1 in. below the crown sheet. About half an hour later dry steam issued from the gauge cock 2 in. below the crown sheet. Water was then pumped in by means of the fire engine until the crown sheet was covered. The boiler was then examined and it was found that nothing had given way. The fire was again started and the water level allowed to drop until it was 2 in. below the crown sheet, as shown by the lower gauge cock, and this condition was allowed to continue for 15 minutes, the water level, of course, dropping below this point and the crown sheet becoming very hot. Water was then again pumped in, and it was found that the stay bolts were leaking, and that the crown sheet was slightly bulged, but in other respects no damage had occurred.

It will be seen from these facts that this test, while interesting, has very little value for modern conditions, and is really more of historical than actual importance. Since that time, however, similar tests have been made abroad, in some of which steel fire boxes were used, which conclusively show that up to a point where a stay supported fire box sheet becomes hot enough to lose its strength and permit the stay bolts to pull through the metal there is no danger of a rupture of the sheet, or of an excess pressure on the boiler by pumping in cold water.

THE MAN AND HIS WORK

A recent innovation of the Erie Railroad in placing the name of a trusted engineer on either side of the cab of his locomotive is decidedly a move in the right direction. This man handled the same engine for a very long period; he contributed toward few, if any, engine failures, and he kept the machine out of the shop for a phenomenal period, as such things are measured, before heavy repairs became necessary. The interest which he feels in his locomotive is largely proprietary. He would not accept maybe a better paying run because he could not take it along with him on the new job. Now the company gracefully recognizes his faithfulness and skill by identifying him with his engine and it with him.

We think well of this departure, and are confident that it will bring results in widespread efficiency which will prove most gratifying. It is a very common old world procedure, and was particularly recommended in instances of special worthiness by the late M. du Bousquet of the French Northern Ry., one of the most able demonstrators of the art of handling men who ever held an executive position. His splendid locomotives on the Paris-Calais line, the fastest passenger service for the distance in the world, bear prominently the names of their engineers and firemen. The London, Brighton and South Coast Ry. paints the name of any engineer of proved efficiency in his cab; the London and North Western has it under consideration, and many continental roads have adopted the practice as standard.

It conveys a hidden but nevertheless undeniable appeal to any engineer and fireman, despite the fact that it would be difficult to define its exact nature. It is an assurance on the part of the company that the locomotive in question will remain in possession of its master, and that he will thus be publicly proclaimed as a good engineer just as long as the honor is merited. There is not a man in this world so indifferent as not to be appreciative of this, and who would not be reluctant to see those big gold letters effaced from under his cab windows. It is equally safe to assert that anything he can do will be exercised to keep them there.

A too liberal application of the idea might perhaps lessen to some extent the high degree of honor so conferred, but the Erie can be trusted not to fall into this error. So far there have been but three locomotives on the system thus adorned, but vastly more than three of its engineers are struggling for like preferment. No mistake has been made by this railroad in establishing a plane of superior and recognized merit, and it is a departure which may be followed to advantage in the locomotive practice of any country.

THE HEAVY GRADE LOCOMOTIVE

The interesting paper by F. W. Bach on the design of locomotives for smooth rail working on heavy grades, recently presented before the Institution of Civil Engineers, and which has been carefully reviewed elsewhere in this issue, is well worth a thoughtful perusal despite its manifest theoretical aspect. Some of the points which Mr. Bach makes, notably the reference to the performance of the Mallet compound owned by the Baltimore and Ohio Railroad, are very good, and, while we cannot entirely agree in the majority of deductions which he has drawn, there is still obvious food for speculation on whether the right track is being followed in dealing with this particular problem.

For a thorough appreciation of what the writer of the paper is attempting to bring forth the reader must be in sympathy with the proposition of lighter loads and more frequent trains than those which appeal to the management of our railroads. The diagrams submitted with the paper are ingenious, if not entirely convincing. Nevertheless, although theory has been largely featured, Mr. Bach has not been by any means devoid of the opportunity to convert his ideas into practice. From his assignment to design suitable power for this work he is enabled to draw inferences and conclusions of particular value.

The Oxy-Acetylene Cutting Torch

THE DEVELOPMENT OF THIS APPARATUS HAS BEEN SUCH THAT IT IS NOW ACCORDED GENERAL RECOGNITION AS AN INDISPENSABLE ADJUNCT IN THE SOLUTION OF MANY METAL WORKING AND HEAVY ENGINEERING PROBLEMS.

J. F. Springer.

The value of the oxy-acetylene welding torch has been thoroughly discussed and illustrated in a recent number of this journal,* but it is doubtful if the importance of the device as a metal cutting medium is generally recognized. Within a comparatively recent period it has successfully emerged from the experimental stage along these lines and can now take care of a wide range of work heretofore considered as practically impossible without almost prohibitive costs.

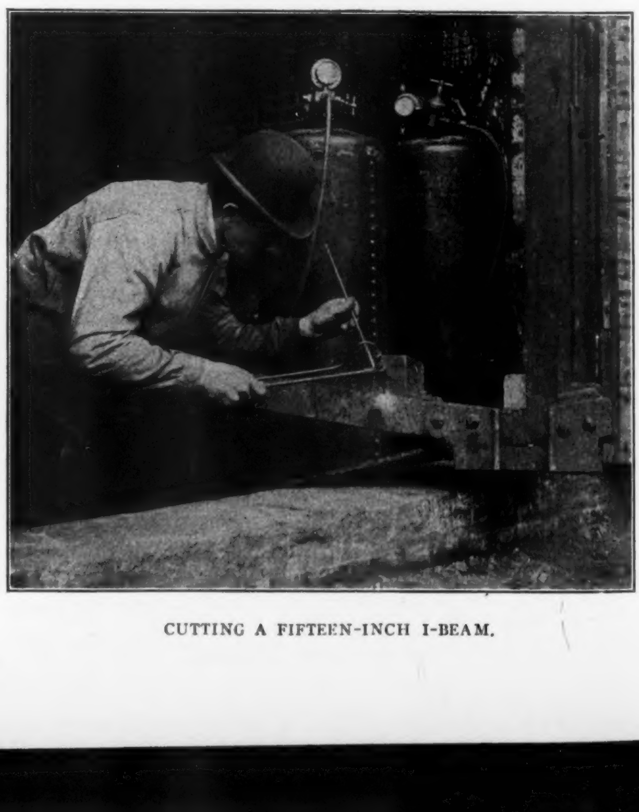
The operation of the torch is no doubt generally understood in its application to welding or "fusing" operations, and an explanation of its cutting properties will no doubt prove of interest in supplementing what has been said heretofore without any elaborate description of the appliance itself, which would merely be in the nature of a repetition.

THE OXY-ACETYLENE CUTTING TORCH.

The method of cutting employed is, briefly, as follows: Oxygen and acetylene are supplied to the welding nozzle as usual. These gases are there mixed together in suitable proportions. Upon issuing from the tip, they are ignited by the flame and are burnt. There are two flames—an inner one, bright and excessively hot; and an outer enveloping flame, dull and comparatively cool. The steel to be cut is heated to a very high temperature by means of the little inner flame, but no cutting of an appreciable amount is done by this flame. The purpose of its application is to get the metal to a high temperature at the point of cutting. A second nozzle terminates quite close to the tip of the heating nozzle. Through this, oxygen is driven under pressure. Consequently, a thin stream of rushing oxygen strikes the highly heated metal with the result that the latter is quickly "burnt up," but only locally. By moving the combination of two nozzles along, the metal will be "eaten" or burnt away. It is quite possible to make a narrow and deep cut.

Assuming that the action of the inner and the enveloping flame are understood, it may be said that the operation of cutting with the torch is not unlike sawing. The flame and oxygen jet are directed downwards with the upper part (as the position now is) inclined slightly towards the direction in which the cut is to be made about in the same way a board is sawed with a hand saw, except that with the flame and jet the obliqueness is perhaps, as a rule, considerably less. The material removed flows down and off, just as with saw dust. The forward profile of the cut, however, is not straight but curved, and this curve swings backward more and more as the bottom of the cut is approached. All this is, of course, different from the cut made by the ordinary saw. But the two procedures resemble each other in that the cut extends clear through from upper side to lower. It must not be understood in this connection that the cutting goes on slowly as a steel bar, 6 inches on a side, has been cut through in 1½ minutes. The consumption of oxygen is not at all extravagant. For this cut 10 cubic feet were used, costing about 25 cents, but it may be said that this is, perhaps, an unusual case and can scarcely be equalled every time. It is recalled that the expense of cutting a 6-in. shaft, including, no doubt, the cost of the oxygen and acetylene used in heating as well, was 37½ cents.

In one of the illustrations is a view of the cutting operation while it is going on. The I-beam in this case is 15 inches wide, and such a beam may be cut through in less than 3 minutes. The flying *debris* is to be seen streaming off to the right. It will be observed that there are two tanks, both containing oxygen. The reason for two tanks is that the pressures advisable are different for the heating torch and for the cutting attachment. Both are used in carrying out the cutting process. The oxygen supplied for the heating part of the procedure in cutting the 6-inch square bar was probably at a pressure of no more than 16 or 18 pounds per square inch, and the oxygen flowing through the cutting tip was at a pressure of 125 pounds. When the cutting is light, there is greater approach to equality in the two pressures. Thus with very thin sheets of ½-in. thickness or less, the pressure of oxygen passing through the heating nozzles will range, say, from 14 to 18 pounds; while that passing through the cutting nozzle will have a pressure of, say, 20 pounds. For sheets varying from ½ to 1½ inches, the oxygen of the heating jet will be



CUTTING A FIFTEEN-INCH I-BEAM.

* See American Engineer, November, 1910, page 431.

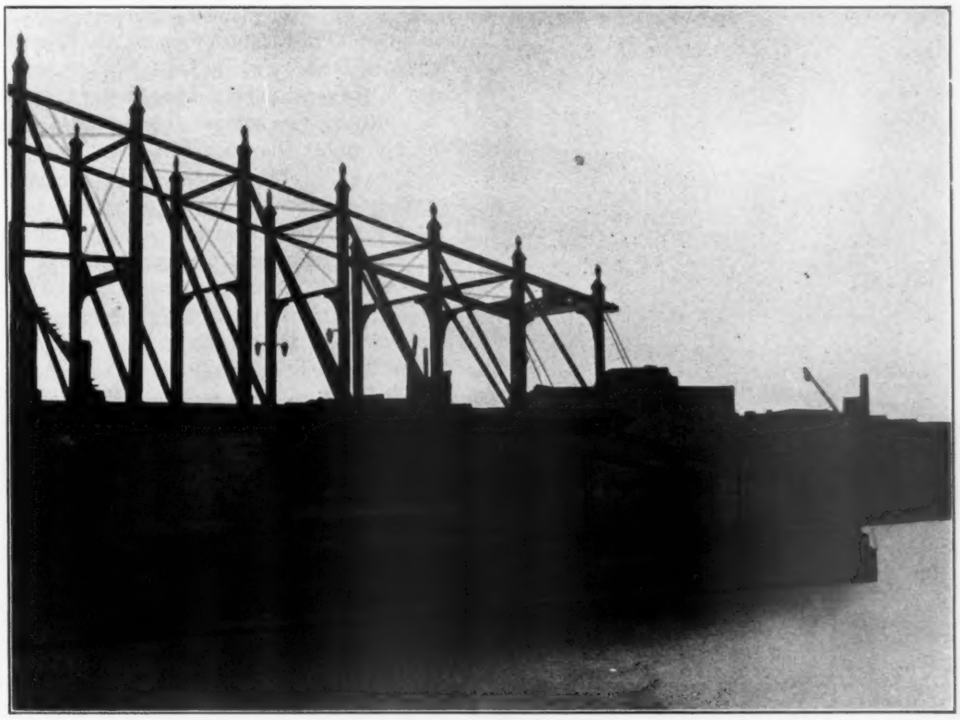
about the same as before, while that of the cutting jet will be increased to, say, 30 pounds.

One great advantage the oxy-acetylene method of cutting possesses is the ease and economy with which it can be applied in difficult situations. Those who have to do with the clearing away of steel wreckage know what such difficulties mean, or those who have to dismantle steel structures that are to be abandoned. An example of dismantling occurred in connection with the removal of a portion of the steel bridge crossing the Harlem River in New York City at 136th Street. The central portion of this structure was used as a draw. It was this section where the oxy-acetylene cutting process was put into operation, and steel to the amount of 450 tons was involved. There were regulation I-beams, riveted I-beams, and riveted vertical supports. The cutting process was employed to divide the structure into seven manageable parts.

but with the Davis-Bournonville apparatus the whole job was done in one day. The whole was cut up into 13 pieces, that is to say, each end was cut into two pieces, and each side and the bottom into three pieces. It is said that to have dealt with the matter in some other way would have taken a week or ten days.

Nickel steel, as is well known, is very tough, and consequently is difficult to cut by ordinary means, but the oxy-acetylene process knows but little difference between nickel steel and others. Certain portholes had to be cut recently in nickel steel plate 15/16 in. in thickness. It is said that by the old method of chipping, even though the most up-to-date tools should have been used, each porthole would have required two or three days' work. With the oxy-acetylene cutting appliances, 125 such holes were cut in an average time of about six minutes per hole. That there is a tremendous economy here is very evident.

It will readily be understood that, in the great variety of cutting work, the manipulations required must be quite diverse, although there is a good deal of such work where the conditions remain pretty constant. In such cases it will often be advisable to use mechanical means for handling the cutting apparatus. A precision can be attained when mechanical means are employed that would either be difficult of attainment otherwise, or would consume too much time. There is a mechanical device with which the cutting torch can be moved across sheet steel by means of a hand screw. With ½-inch steel plate and 15 pounds pressure on the cutting oxygen, a speed of 1½ feet per minute can be attained; with 9/16-inch plate, 15 pounds pressure, 1¼ feet per minute; with ¾-inch plate, 25 pounds pressure, 1 foot per minute; 1-inch plate, 32 pounds pressure, 1 foot per minute; 1¼-inch plate, 42 pounds pressure, 1 foot per minute. The cuts are only about ⅛ inch wide. Heavier work can be done, as already pointed out. In fact, a thickness of 14 in. has been cut, and it is impossible to say where the limit is.



STEEL BRIDGE DISMEMBERED BY CUTTING TORCH.

There were two outfits employed. A large floating derrick would be manœuvered to take the weight of the section about to be removed. The several beams would then be cut and the section lowered to the grillage of the fender, where further dismemberment would be carried out by other means. The first two sections thus cut and lowered averaged about 25 tons each. The next two weighed about 66 tons each. The four central columns were lowered together. In dealing with the swing span it was found necessary to block up one end, the weight being unevenly distributed. The first cuts were then made at the other end. The management of this matter was perhaps the most difficult of all, because of the care necessary. However, all operations were executed in a week's time, and the long span completely removed. It is said that the removal by former methods would have occupied from six weeks to two months. The consumption of gas was quite moderate. Of acetylene, about 450 cubic feet were used; of oxygen, about 1,500 cubic feet. The total value of the gases was about $42.

Another illustration of the ease of application of the oxy-acetylene cutting process was furnished at 95 William Street, New York City. Here it was desired to remove a large steel tank constructed of ½-inch sheets. The tank was 4 x 8 x 10 feet in size, and so situated that a sledge could not be used to cut the rivets. It seems that it would be possible, however, to move it a short distance, cut off a section, then repeat the moving and cutting, and so on. This would scarcely have been a rapid method,

Another type of work is in connection with steel castings. The risers on these can be cut away by this process. It is possible to compare results here with what has been accomplished with the saw. Using the saw, 181.69 cubic inches have been cut in 405 minutes. This seems to be the actual cutting time, and the 181.69 cubic inches to represent the day's work. The labor cost, $1.90; grinding the saw, $0.86, so that, excluding power, the total cost was $2.76. The average cost per cubic inch would thus be $0.0152. With the oxy-acetylene cutting torch, 135 cubic inches

were cut per hour. The labor was estimated at 25 cents per hour, the acetylene at one cent per cubic foot and the oxygen at two cents. The expense per cubic inch of steel was found to be $0.0080, or but little over half that with the saw. The foregoing data are based on results at a plant where steel castings are made

It is important in the application of the cutting process, just as in the welding procedure, to select the proper size of tip for the work. Thus, the smallest heating tip (No. 00) consumes only 0.6 cubic feet of acetylene per hour, while the largest size (No. 12) consumes 145.8 cubic feet. The amounts of oxygen can be estimated from these figures by remembering that in the neutral flame (i. e., one that neither oxidizes nor carbonizes) the oxygen must be furnished in the ratio of 1.28 to 1. We have

CUTTING OFF STEEL PILING.

the 0.786 cubic feet of oxygen per hour for tip No. 00, and 186.6 cubic feet per hour for tip No. 12. Remembering that acetylene costs about 1 cent per cubic foot, and oxygen about 2½ cents, the corresponding costs can be estimated. It will be seen, then, that money may easily be wasted by using a tip larger than necessary, and while this is true for the heating tip, it is still more true for the cutting attachment.

The reason is that a higher pressure is ordinarily used for the oxygen cutting jet. If too large a jet is used, there will consequently be a considerable loss. The process is an economical one, but expert advice obtainable from the makers of the instruments should be closely followed. Thus it is practicable to cut 6-inch steel with a flow of gases that make a cut of only ⅛ or 9/64 in. wide. It will readily be granted, perhaps, that if a cut of double the width had been made under the same conditions, the expense would have been much greater, as double the metal would have had to be removed.

In order that it may be appreciated how effective this cutting method is with heavy work, the example may be cited of a cut 18 feet long made in steel 3½ inches thick. A pressure of 85 pounds was here employed with the oxygen cutting jet. The entire operation was completed in less than half an hour. A cut nine feet in length was made in 1-inch steel in 10½ minutes, and the cutting pressure was 35 pounds. This should be compared with a long cut made in ⅞-inch steel, in which latter mechanical means was employed to regulate the apparatus. The cutting pressure was 40 pounds, and the cut 6½ feet long was made in 3¼ minutes, or at 2 feet per minute. This is more than double the speed of the former example, and scarcely seems to be explained by the slightly increased pressure and the slightly thinner metal. Another mechanical cut, 6 feet long and ⅝-inch deep was made in 2½ minutes. A circular cut in 1-inch steel, 1.54 feet long, was made in ¾ minute. Calling these four examples A, B, C, D, we may compare the areas of the cuts and the periods thus:

Example.	Area in Sq. In.	Time in Min.	Sq. In. per Min.
A	108.00	10.50	10.3
B	68.25	3.25	21.0
C	45.00	2.50	18.0
D	19.50	.75	26.0

As to the amount of oxygen used, we may take the figures obtained after 16 miscellaneous cuts. The total area cut amounted to 187.5 square inches. The total amount of oxygen used, both through cutting and heating tips, amounted to 42.5 cubic feet We find then that it requires 0.288 cubic feet of oxygen per square inch. The total acetylene may be estimated at 4 cubic feet. With acetylene at 1 cent and oxygen at 2½ cents, the total expense for gas would be $1.10. Per square inch, the gas cost would be $0.0059. If we estimate the labor at $0.0011 per square inch, we get for gas and labor a total expense of $0.007 per square inch.

THE PENNSYLVANIA'S RELIEF FUNDS

Since the organization of the Pennsylvania Railroad Employees' Relief Funds, $29,571,266.72 have been paid out in benefits to their members. This fact is brought out in a report issued recently by the company, which also shows that in the month of November the benefits amounted to $189,386.30.

The Relief Department of the Lines East of Pittsburgh and Erie in the month of November paid to its members the sum of $129,452.75, representing $52,473.43 paid to the families of members who died and $76,979.32 to members who were incapacitated for work. The total payments on the Lines East of Pittsburgh and Erie since the Relief Fund was established in 1886 have amounted to $21,504,660.81.

In November, the Relief Department of the Pennsylvania Lines West of Pittsburgh and Erie paid out a total of $59,933.55, of which $19,812.50 were for the families of members who died, and $40,121.05 for members who were unable to work. The sum of $8,066,605.91 represents the total payments of the Relief Fund of the Lines West since it was established in 1889.

GOVERNMENT TESTS OF LIGNITE.—North Dakota Lignite as a Fuel for Power-Plant Boilers is the title of Bulletin No. 2, just issued by the Bureau of Mines. This bulletin describes a series of tests at the pumping plant of the United States Reclamation Service, at Williston, North Dakota. The Reclamation Service has a large project there, and had installed steam boilers with furnaces designed to burn a "brown lignite" that was mined on adjacent Government land. The results of the tests on the lignite show that this fuel, though generally considered unsatisfactory, may be used with fair economy under boilers that generate their full rated capacity. The tests were conducted by the Technologic Branch of the Geological Survey which is now a part of the Bureau of Mines. The authors of the bulletin are D. T. Randall and Henry Kreisinger. The bulletin will be of interest to fuel engineers, especially to those located in lignite territory. It may be obtained by addressing the Director of the Bureau of Mines, Washington, D. C.

CONSIDERABLE OBJECTION FOR A TIME was raised to the establishment of the apprentice schools on account of their cost. While we know exactly what it costs us to educate each apprentice, we also know what the apprentice is doing, and although the Santa Fe is spending from $35,000 to $40,000 a year training boys for its future needs, yet with the help of their school and shop instructors, these boys are accomplishing enough more work to more than pay for the most of instructing them.—*F. W. Thomas, Supervisor Apprentices, A., T. & S. F. Ry.*

A NEW UNION STATION IN THE CENTER OF BALTIMORE, with a tunnel connection running for about two miles from the western boundary of the city under the business district, are the main features of a report by a self-appointed committee of business men having in view practicable relief to the congested conditions of the railroads in that city.

THE MECHANICAL HANDLING OF FREIGHT

At the meeting of the American Society of Mechanical Engineers in New York on January 10, a paper on the subject of "The Mechanical Handling of Freight" was presented by Samuel B. Fowler, of Boston. The subject was discussed by railroad officials and by officers of large industrial establishments where the handling of great quantities of freight is a serious problem. Lack of adequate terminal facilities, increase of net income and lower freight rates present problems, the solution of which are vital to the transportation company, shipper and consignee alike. Additional facilities are difficult to obtain, since there is usually no available land adjacent to the terminal or it is held at a prohibitive price.

The capacity of present terminals can be increased by handling larger unit loads and moving them at greater speed, as well as by increasing the flood areas by the use of freight sheds of more than one story. This is made possible by the substitution of mechanical devices for manual labor and hand trucks. The terminal handling cost is a large item in freight charges. Mechanical handling methods will reduce the total transportation cost sufficiently to permit of a material gain in income, a decrease in rates, or possibly both. The use of machinery will also bring about a new type of terminal and a revolution in present terminal methods, making possible other economies. These economies are possible with team freight as well as less than car load freight, and with water-borne as well as rail-borne traffic.

To the Editor:—

In order to set us right with your readers, I think I am justified in asking you to publish the following, in order that I may not be misunderstood by them in regard to the application of our patent tube plates to existing fireboxes in locomotive boilers. We have been applied to by a number of superintendents of motive power to do this, but as this is only one part of the boiler considered, and then not in accord with our plans, we wish to explain through the medium of your paper that we are very willing to supply our patent tube plates where they can be fitted to existing boilers to conform with our plans. It is our best judgment to advise a railroad company to first make trials with a number of new boilers or with complete new back ends and tube plates fitted to their regular type of boiler. In this way they will get economy enough by the increased heating surface, diminished staybolts, improved circulation, no broken stays, non-leaky mud rings or flues, to repay them many times for their expenditure.

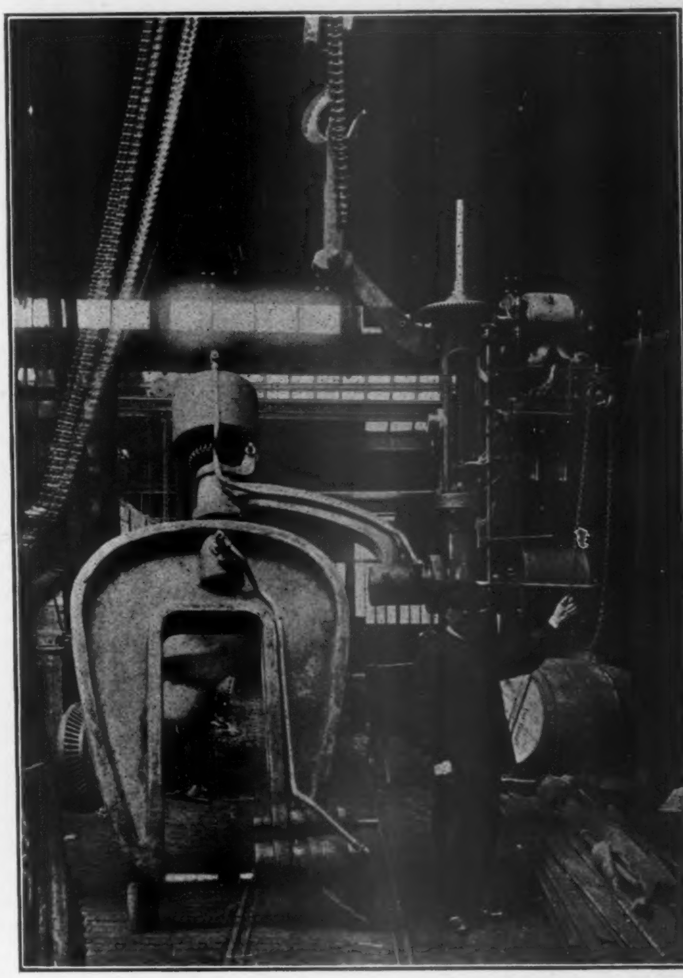
What I state in regard to our boilers is from knowledge of construction, and from the daily inspection of their working going on the third year. It is not requisite to make a demonstration test by heating the plates over crown of our firebox to note the variations of steam pressures by injecting water whilst plates are so heated, inasmuch as it is a well-known fact that the formation by corrugation of firebox and tube plates adds over 50 per cent. to the strength of a regular firebox besides adding flexibility, which neutralizes the strains under the conditions in which a locomotive boiler works. Shall be glad to furnish statistics of the working of our boilers and any other information required, but deem it best not to accede with the wish of motive power to apply our tube plates to existing boilers unless changed to conform with our regular plans.

Wm. H. Wood.

More Than 1,500,000,000 Passengers rode on the various transportation lines in Greater New York during the year ended June 30, 1910. Traffic figures made public recently by the public service commission gave the total at 1,526,966,988, as compared with 1,396,086,252 for the previous twelve months. The fares collected by the various companies totaled $76,224,179.63. Operating expenses of the roads for the year were $43,274,487.11.

AN ELECTRO-HYDRAULIC RIVETER

This extremely interesting tool is coming into extensive use in European railroad shops. It is a very clever device and possesses many points of merit. In it the well-known advantages of hydraulic riveting are secured, with the additional good feature that the tool is self-contained and needs no outside water pressure supply or piping. A small electric motor gives the hydraulic pressure, and it has been found that one of two horsepower will suffice. Pressure is given by driving down the piston shaft by the motor through gears and a revolving nut which is threaded on the end of the shaft. The operation of riveting does not require over five or six seconds per rivet, and can be performed with a single lever, the riveter returning automatically to the starting point after each rivet is set.



ELECTRICALLY OPERATED RIVETER.

The setting of the rivet is done in the proper way; that is, quickly at the beginning of the work on the hot rivet, and then slower as the rivet head is formed and as the pressure increases. The metal is thus forced in the hole in a gradual manner and provides a perfect filling, even in cases where the holes cannot be drifted to exactly match. By properly setting the cams a great range of pressures, according to size of rivets, can be obtained. This is an advantage over the usual hydraulic tool which gives but two or three different pressures.

For some kinds of work a universal mounting is used so as to allow the riveting tool to take any position where the rivets are differently situated. This is, of course, a requisite in boiler work where the tool must be convenient to handle. It is well secured by mounting the riveting jaws to turn on a frame upon a shaft, and the frame is mounted in a like manner on the main casting. The latter is hung by an arm from a crane as will be seen in the illustration. Rotation of the two parts is given by a ratchet device and endless screw in each case. The whole system is mounted so as to turn on ball bearings and it can be moved very easily by the workman.

Locomotive Fuel Economy

ABSTRACT FROM A MOST VALUABLE PAPER PRESENTED BEFORE THE RAILWAY CLUB OF PITTSBURGH, IN WHICH THOROUGH INSTRUCTION AND DEMONSTRATION ARE ADVOCATED AS POTENT FACTORS.

A. G. KINYON.

Instruction is the key-note to fuel economy, but to be effective, it must be followed by supervision and demonstration. Instruction by means of books on fuel economy is good, instruction by correspondence courses is also good, and instruction by lectures direct to the men is best, but if any or all of these made up of proper information, are supplemented by practical demonstrations on the engines and followed up by constant supervision, the nearest to ideal conditions will obtain. Instruction in whatever form should be given, not only to engineers and firemen, but to roundhouse foremen, boiler makers, hostlers, hostler helpers, fire builders, engine watchmen, grate men and fire cleaners. And if officials of the operating and mechanical departments attend the classes occasionally, it will have a good influence, as well as keep them posted as to what instruction is being given and so be in a position to give support in having the instructions carried out.

Upon the roundhouse foremen, boiler makers and grate men should be impressed the importance of having the draft appliances, grates, flues and all parts that make for fuel economy, in proper condition when the engine goes out, and a clear understanding of what proper conditions are, should be insisted upon. Hostlers, hostler helpers, engine watchmen and fire cleaners should be instructed in proper methods for building the fire, its care up to the time of delivery on the going out track, and the condition it should be in when delivered, proper methods of cleaning the fire, and when these men are in line of promotion to the position of fireman, they should receive the same instruction given to firemen.

The present method followed on most roads of sending a new man out as a student fireman to learn to fire from a fireman who possibly may be making his first trip for pay, is the poorest possible. It is the failure to do successful work when so started that causes so many to become discouraged and quit, and thus keep the service filled, particularly in a busy season, with green, dissatisfied and unsatisfactory men. And this practice brings about a method of firing by which the fireman keeps up steam when all conditions are right, but which is very extravagant in coal consumption, and when adverse conditions are encountered, result in steam failures. All this would be obviated if proper methods were followed from the start. It should be the aim to get these green men into the instruction car before they make a trip and give them a clear understanding of the theoretical part of the work, as well as an explanation, so far as possible, of the practical part, and then their first two or three trips, or more if necessary, should be made with the demonstrator instructor to give them a right start, and a right start is of the greatest importance in any undertaking.

The demonstrator instructor should have only such territory and men under him that he can ride with each man at least two or three times a month and in this way keep them up to proper work. While it is a fact that the engineers and firemen receive the highest pay outside of official positions on the road, it is also true that the majority of them need, like other employees, direction and supervision. No management would think of starting men in the shops without some direction and supervision, and the supervision would be continued at all times. The man, who by his faithful work, shows that he does not need supervision, is the one who is promoted.

The cost for material for repairs to our locomotives is only about 40 per cent. of the cost of fuel to operate them, while the cost of labor for repairs and terminal care is only 46 per cent. of the cost for fuel and labor to operate our locomotives, so it would seem reasonable to assume that the same amount of supervision be had over this labor and material as is had in shop management, but have we? No, far from it; it is safe to say that for every 20 first-class workmen in our shops we have a foreman. How many foremen or road foremen of engines have we on our 57,000 locomotives? No exact figures are obtainable, but we think that one road foreman for every 150 engines is a safe estimate. In the face of these figures no intelligent man can deny the fact that great saving can be brought about by closer supervision of the men on the engines. We believe there is work enough outside of the matter of fuel economy for the road foreman and it would be one of the best possible investments to train a corps of men especially for this work, and have enough of them so there would be at least one for every fifty crews.

The first essential is a well equipped instruction car, fitted up with apparatus and in charge of a competent instructor, who, where possible, should be a practical engineer. The difficulty of securing practical men as instructors will no doubt be great, but arrangements could be made with some of our technical schools to train men in the theoretical part of the work, or supply instructors to work with the practical man in the education of the men. In fact, we believe that the extension department of our state college would be only too glad to train men along these lines, could they be assured of openings for them, or the Scranton schools, through their railway department, would either instruct the men direct, or furnish instructors.

Besides apparatus for instruction on the principles of the chemistry of combustion, other apparatus should be provided for distilling the gas from coal, and catching some of it, and showing how it can be used to advantage, or how much or all of the gas may be lost by improper methods of firing, evaporation test apparatus in which some of the gas from the coal can be burned, and the economy of a slow rate of combustion over a rapid rate shown. Show that the rapid rate is the one where the black smoke is made, and that the black smoke is the carbon of the hydro-carbon gases, and represents a loss of 14,500 B.t.u. for every pound so escaping, also that with black smoke is escaping quantities of partially burned carbon in the form of a colorless gas known as carbon monoxide, and that each pound of carbon so burned represents a loss of 10,000 B.t.u. That the formation of the smoke and the carbon monoxide is due to supplying coal faster than the draft appliances can supply oxygen through the medium of the air to burn it. The matter of draft and draft appliances and their adjustment should be gone into with the help of stereopticon pictures. These pictures should show the interior of the firebox with the fire burning under different conditions, a view of the front end as well as the boiler in longitudinal section. The necessity of having the air come in through the grates to have the oxygen thoroughly mix with the fuel elements of the coal should be brought out strongly, and in this connection the necessity of swinging the door after each shovelful of coal is put in, should be impressed. Also that the air mixes best with the coal if a light fire is carried and the fresh fuel added in thin layers. Views should be shown on the canvas picturing the improper fire as well as the proper one.

A fire with a hole in it should be shown, and the exact reason such a fire will not produce heat explained; also a clinkered fire, and what the presence of the clinker means and how to avoid it. A picture showing a tender properly coaled and trimmed should be shown, and any other views that local conditions make desirable. The importance of co-operation of the engineer and fire-

man should be taken up and strongly impressed on the men. Instruction in this way, or when this is not convenient, instruction by means of carefully prepared instruction books, will lay the foundation for the most important part of the work, namely, the demonstration on the engines in actual service. This world is certainly filled with many Missourians and a large number of them are to be found on our locomotives, so many in fact that I sometimes wonder if that state is not becoming depopulated by emigration, as so many of the men have to be shown.

The demonstrator instructor should be an engineer of not less than two years' experience in that position, who thoroughly understands the theoretical part of the business, and who is able to take the scoop and fire an engine over the entire division if need be, to show that the theoretical part is practical in service, and when the two are combined far better results will be had than with either alone. Show how the fire should be built up at leaving time, so that when stirred out or broken up, as the start is to be made, that a clean bright fire will be had, one that is even in thickness over the grates, and only just heavy enough to stand the work the engine is to do. Show how if the fire is bright all over and not too thick, the air will come through equally at all points, the fire will not be torn in holes, and much less coal burned than if the start was made with a dull, heavy fire. That by firing light and often, and taking pains to break up the large lumps, and covering as large a surface as possible with each shovel of coal, and the door closed after each shovelful, that much less coal will be used, an evener steam pressure maintained with less labor, smoke eliminated in a great measure, and his work for the company more economical and satisfactory.

The practice of leaving the door on the latch after each scoop of coal or after each fire to prevent smoke, if effective, is simply a second wrong to be made aright, the first error being in putting in too much coal at a time or too often. The truth is that there is a wrong understanding on the part of many as to how or under what circumstances black smoke is formed. Many believe that the smoke is formed on account of low firebox temperature, when in fact it is impossible to form black smoke unless we have a temperature of at least 1,800 degrees F., for the reason that the smoke is the unburned carbon of the hydro-carbons and does not become visible until it is separated from the hydrogen, and this separation does not take place until a temperature of 1,800 degrees is had. At this temperature, if there is an abundance of oxygen present and in touch with these fuel elements, they will both burn, and only colorless gases will be produced. In most cases, where opening the firebox to prevent smoke is effective, it is due to the fact that the cold air admitted above the fire in this way chills it below this splitting-up temperature and the gases escape in their compound form, and we then not only lose the carbon, but the hydrogen as well, and will have to use considerable more coal to make up for this loss.

Show him that the proper time to add fresh coal is after the gases of previously added coal have all burned off, and the fire is burning with that white incandescent heat that is so blinding when you look at it. Call his attention to the fact that the coal must be added at just the right time, and if so added there will be no danger of the fire getting away from him. This is one of the hardest things to teach a man and can be done only by practical demonstration. The writer has had many firemen say: "I did not believe it possible to fire an engine with such a light fire and would not have dared to try; but now I see it can be done, I am going to do it." Abuse of the fire on the part of the engineer in allowing the engine to slip, leaving the lever down too long in starting the train, or failing to hook up when tipping a hill, or upon striking a sag or flat place, is often the cause of heavy fires and extravagant methods of firing followed by so many firemen. If the fireman has the experience of having his fire taken away from him once or twice by such practice, he will ever afterward be inclined to go "loaded" for all comers, as he would rather be censured for having too much coal in the firebox than for not having enough, even though the heavy fire will not produce as much steam.

The harmfulness of this wrong practice on the part of the engineer should be pointed out to him very clearly and proper methods of handling his engine insisted upon. The importance of shaking the grates to keep them free from ashes and clinkers as far as possible, should be impressed on the fireman, but at the same time he should be cautioned not to shake them too often or too hard. The fireman should be taught to use his head, to figure ahead and have the condition of his fire right for different parts of the road, so that when a shut-off is to be made the fire will have burned down so that if the engineer has figured to have room in the boiler for water and increases his water feed before closing the throttle (if he does not do this he should be instructed to do so), the pops will not lift and black smoke will not trail over the train. While it is quite proper and essential to let the fire burn down under these conditions, he should also be impressed with the necessity of not going to an extreme, so that when steam is to be used again there might be a failure of pressure, or more coal required to build the fire up again than was saved by allowing it to burn down.

We think it is understood that all efforts to fuel economy must be subservient to the conditions necessary to pull the tonnage and make the time required, and if one method will do this and another will not, the most effective method must be followed, although it has been our experience, when the engine is in even fair condition, the best results will be had when the light and frequent method of firing is followed. The engine crew must work together to get the best results, so the instruction should be understood alike by them. They should figure, upon reaching a terminal, to have the fire in such condition that after the engine has been left on the terminal track by them, the pops will not open and waste a lot of fuel, neither should the water be left too low or the fire so low that it will die out, particularly at the flue sheet, before the engine will have been taken care of by the hostler or engine watchman. The fire, water and steam pressure should be as outlined in a previous paragraph on "Condition of fire at completion of trip."

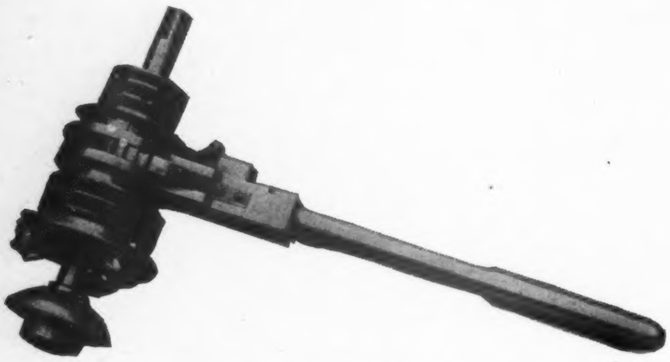
The exact relation of the traveling engineer or road foreman to the demonstrating instructor, or just what his title should be, is a matter that will have to be worked out locally. The title certainly should not be traveling fireman on account of lack of prestige such a title would produce, and the duties of this man should be apart from those of the road foreman. On the Erie this scheme is being worked out experimentally on two divisions by a man on each division with the title of supervisor of locomotive operation, who has full authority over the men so far as the proper operation of the locomotive is concerned, and who looks after the draft appliances as well as other parts or conditions that make for fuel economy, and they are getting remarkable results.

We believe that no man should be placed in the position of demonstrator instructor who cannot take the scoop and demonstrate every point, or if unable to do so, point out clearly what improper condition prevents proper results being had. While we do not believe he should fire an entire trip at any time, unless in case of emergency, he should fire far enough to demonstrate to the doubting ones that the method of light and frequent firing can be followed, not only for a few miles, but for many, not only in light service, but in the heaviest kind of service. He should also impress upon the fireman when he takes the scoop that it is not for the purpose of relieving him of his work, but is purely instructive, and he will be expected to follow methods and get results as shown. In riding on poor steaming engines, to determine what the cause of steam failure is, he should watch the operation on the part of the engineer, test for valve and cylinder packing leaks, and fire the engine himself to determine accurately where the trouble is. The engineer should be instructed on these points as well, so that the common report of "engine don't steam" will be supplemented with an explanation of "why," so the roundhouse foreman will know what to do to overcome the trouble. He should have the supervision of the hostlers, fire cleaners and engine watchmen and the condition of the fires at terminals. His report on quality of coal used and manner of charging it to engines, should have much weight.

TOOLS FOR FLUE AND SHEET REPAIRS

WESTERN RY. OF FRANCE.

Flue and firebox troubles which have been particularly prominent in connection with the locomotives of certain European railroads have of late acted as the stimulus for a vast amount of ingenuity in the evolution of special devices for performing work, and for correcting abnormal conditions. Some of these devices are radical departures from those employed in flue setting in this country, and the methods of heavy firebox repair work exhibit a decided variance, but both the tools employed and the operations are very interesting, and at least clearly indicate that those on the other side in charge of this work are not lacking in resourcefulness.



THE GALLON FLUE SHEET TOOL.

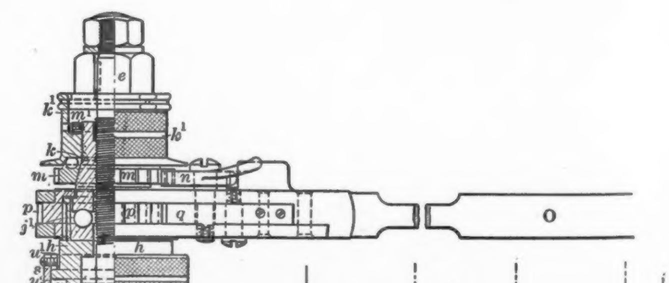
M. Gallon, who is connected with the shops of the Western Ry. of France, has devised and patented many clever appliances for use in flue and flue sheet work which have been adopted by his road, and which are attracting considerable attention elsewhere from the good results which have been achieved. One of his very convenient tools for setting flues is shown in the second illustration. The ordinary method practised prior to its appearance consisted of the use of a dudgeon which dilates the flue and fits it tight inside the hole in the flue sheet. This is followed by the beading process, in which a hammer is used to turn over the bead, and the latter finished with a hand or air beading tool. It was well appreciated by M. Gallon that this work which must be done by shocks is quite liable to loosen the flue in the hole, and in fact to frequently necessitate the re-application of the dudgeon after the bead had been formed. This in turn increases the length of the flue, so that the bead is no longer in contact with the sheet.

It was also shown conclusively through experience that it was not advisable to use the dudgeon too frequently upon the same holes in view of the fatigue induced in the flue sheet and the liability to put it out of shape. Tools of various kinds have been devised abroad for carrying out the setting of flues in a better way, but for many reasons these do not seem to be used to any extent. Either they are too light, and will not answer for the steel flues which are now used for locomotive work, or else they cannot follow the inequalities which many flue sheets exhibit after a certain length of service. Such sheets are frequently deformed to a very great extent in European countries, and are far from affording flat surfaces, so that an appliance suitable for new work will not do for repairing flues.

The flue setting tool designed by M. Gallon consists of a central rod (a) whose lower end carries a conical threaded part (b). On it are mounted the split rings (c) carrying the elastic rings (d). The upper end of the rod has a head (e) by which it can be turned. When this is done the conical part spreads the rings (c) which are strongly pressed against the sides of the boiler flue (f), thus giving a solid fixed point for the appliance to work against. The flue is also held well in place so that it cannot be put out of shape while the tool is turning down the bead (g). Along the rod is a cup shaped collar (h) which carries below a circular rim (i), the latter used as a rolling surface for the set of rollers (j) doing the work. Above it carries a depression with ball bearings (j) which are pressed down by a tightening nut (k). This latter screws upon a thread (l) on the main rod and is worked by a friction collar (m) receiving pressure from a milled hand nut (k') by means of a small bearing. A ratchet wheel (p) worked by a handle (o) carrying a pawl is worked on the main collar (h) and serves to turn it. The box carrying the rollers (u) is mounted upon the main collar as indicated, and there is left a certain play at "u1," "u2" and "u3" so as to allow this box to incline somewhat. The rollers (j) with their pins (v) are mounted so that the pins run in holes in the sides of the box so as to give a still further play. The rollers are grooved at the top so as to fit upon the rolling way (i). On the same rollers is a second groove (z) which is designed so as to work upon the end (g) of the flue (f) and to turn it over in the proper way.

The appliance is worked as follows: It is first blocked in place by fitting it in the end of the flue, and by expanding the rings so as to hold it tightly. The main lever (o) is then worked, and it carries with it the pawl (n) by means of a lug so as to operate the ratchet (m), making the nut (k) turn upon the main threaded rod. To this end a suitable pressure has been given by turning the milled nut (k') by hand. Thus the nut (k) will give a pressure upon the lower collar (h) and the rollers through the ball bearings. At the same time the main lever turns the principal ratchet (p) and therefore the collar (h). By means of the lower rim (i) the rollers are turned about by friction, and work upon the end of the flue so as to turn it down as desired. When the pressure of the nut (k) upon the rod (a) becomes sufficient, the ratchet (m) is released by slightly unscrewing the hand nut (k'), and the tool can thus be rotated without advancing it, or can be advanced as desired so as to complete the operation. Such advance is controlled by the hand nut (k') as through this is thrown on or off the advancing ratchet (m).

The rollers can take the necessary inclined positions for the work owing to the play which is allowed, but in all cases the rollers rest upon the guiding surface (i), and have their side thrust against the rim of the collar. Rollers with different profiles for carrying out various classes of work are shown in the illustration to which the above references are made. When



DETAILS OF GALLON BEADING TOOL.

the operation is finished the pawl (n), which is double, is turned about so as to unscrew the nut (k) and this loosens up the appliance so that it can be removed and placed upon the next tube. Owing to the good work of this tool it is now used in the Western Railway Co.'s shops, and allows of turning down the ends of steel flues to form wide beads. With that company the greatest diameter of steel flues is 2¾ in.

with a thickness of ⅛ in. to 3/16 in. In cases of this diameter the flue ends project from the sheet before beading ⅜ in., while for a 2-in. flue the projection is ¼ in.

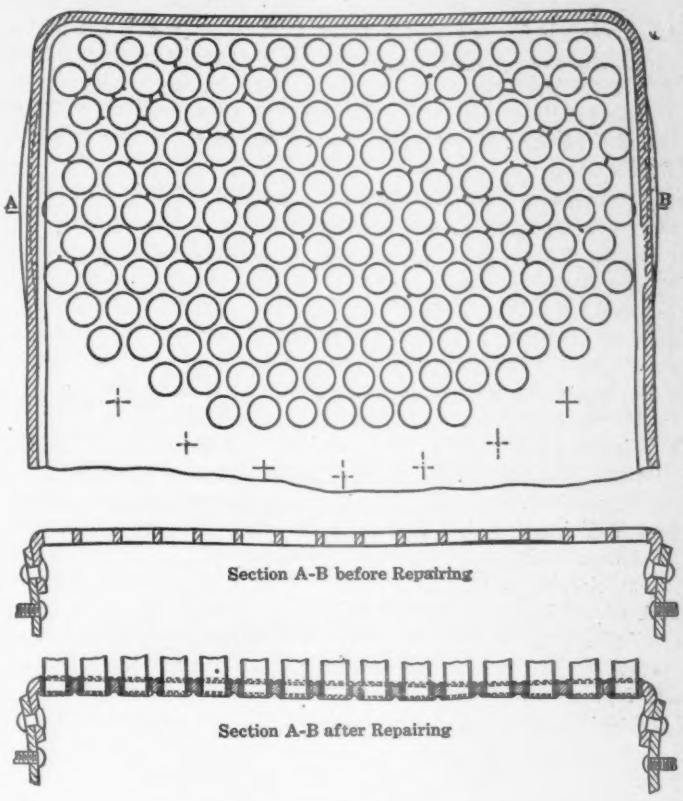
The tool shown in the photograph is the same exactly as that which has been described, except that it contains an inverted ball stem, for use where bushings are used in flue holes before the application of the flue, and which must be beaded on the water and on the firebox side. It is of course apparent that to use this tool the flues must be removed, and in that contingency it adequately forms a bead for the bushing on either side of the flue sheet. A considerable progress in repairing cracked and distorted firebox sheets has been made in France through the Gallon system, in which this last mentioned tool plays no inconsiderable part. In the instance of cracked webs between flue holes the plan pursued is to fit entirely over the damaged area of the flue sheet a sheet of copper, and to secure this latter to the flue sheet by means of bushings in each flue hole, flanged on both the water and the fire sides of the sheet. In view of the fact that a very thin sheeting is employed it must fit down upon the flue sheet surface, no matter how distorted or bulged the latter may be.

So far as securing this sheeting is concerned, M. Ragno, an engineer of the Italian State Railways, uses in the flue hole a light copper bushing made of a section of tubing, and fits it into the hole, afterwards turning the projecting ends down on either side of the flue sheet. An improvement has been made in this method by M. Gallon, who uses steel bushings instead of copper. Through the use of the tool last mentioned he can flange the ends so as to give a wide bead which will hold the copper plating very tight. He modifies the method of holding the tool, which the photo clearly indicates, by substituting the inverted ball stem which has been mentioned, and which is extremely to the point in view of the fact that only a simple bushing need be considered here. The main rod screws into a half-round base which fits upon and pulls against one side of the flue sheet while the other side is being beaded as has been described. Except for the fact that the rollers are designed for forming a wide bead the construction of the applaince remains the same as that which has been described in detail. The inside flange is first made, then the outside, using conical holes to start with, and with the larger opening outward. With the flues all out, and it is presumed in this condition that they will be all removed, copper sheeting can be used on either side of the flue sheet. After bushing the holes with this tool as has been described the boiler flues can be inserted in the bushings and beaded in the usual way with the same tool as that shown in the line drawing by simply substituting the screw end for the inverted ball stem.

Some very clever repair work is being done on the French Western through the use of these ingenious, even if somewhat complicated tools. One of the illustrations shows a back flue sheet in very bad shape. It will be noted that many webs are fire cracked and broken, and that on the section A-B a bulge exists sufficient to practically condemn it in our practice, or at least to warrant a straightening operation of more or less magnitude. This sheet was in fact considered as out of service, but by the Gallon method, and with the tools which have been described and illustrated, it was repaired and returned to work, and has been running for over 18 months, and holding out well. In this case copper bushings were used in the flue holes before the steel bushings were applied, and copper plating was used all over the outside or firebox side of the flue sheet.

These repairs are not entirely applicable to American practice as we are not particularly troubled with broken bridges between flue holes. As a rule when these latter arise it is from some bungling in trying to straighten a bulged back flue sheet, and with the sheet being insufficiently heated it breaks through three or four webs when the draw is applied by means of the screw rods between the front and back flue sheets to straighten the firebox sheet.

It is doubtful indeed whether in American practice it would be considered advisable to run a flue sheet in such condition, but the fact remains that this was repaired and returned to service, and the two comparative cross sections are more emphatic than words can possibly be in illustrating the gravity of the situation and the nature of the repairs. A number of com-



FLUE SHEET BEFORE AND AFTER REPAIRS.

parative tests show that repairs made by this method have been of great advantage, and it has been claimed that 80 per cent. is realized on material and labor, over that represented by a renewal of the sheet. The time for which the boiler is thrown out of service is also lessened some 60 per cent., even although the flues must be entirely removed. M. Gallon states that over 20,000 bushings have been applied by his method in France and elsewhere upon 283 back flue sheets.

OIL AS FUEL IN LOCOMOTIVES.—The use of oil as fuel on the railroads of the United States during the last year greatly increased, the consumption by the roads in 1909 amounting to 19,939,394 barrels, an increase of 3,050,324 barrels, or 18 per cent. over the previous year. The oil used by the railroads is mostly crude. After a thorough investigation by an expert for more than a year, the Great Northern has decided to use oil as fuel on practically all its locomotives west of Leavenworth, Wash., in the Cascade Mountains.

STILL ANOTHER GREAT STEAMSHIP.—The new Cunard liner will be propelled by turbines operating quadruple screws. Her coal capacity will be 6,500 tons and her total displacement 50,000 tons—5,000 tons more than that of the *Olympic*. The design of the vessel will, it is said, include a double bottom so arranged that she may carry oil fuel should the introduction of such a method of raising steam appear advisable. Needless to say, the fittings throughout will comprise every luxury, including a swimming bath, a theatre, and a daily paper. The accommodation will provide for 650 first-class passengers, 740 second-class, and 2,400 third-class—a total of 3,790, which compares with 2,500 in the *Olympic* and 2,200 in the *Mauretania* and the *Lusitania*. The cost of the vessel will probably reach close on to $10,000,000.

THE POWER OF A LOCOMOTIVE BOILER

During the last decade a revolution in opinion has taken place in England with regard to the size of locomotive boilers. It has been more and more recognized that the power of a locomotive is limited by the amount of steam which the boiler can supply, and in this respect there is a tendency to fall into line with American practice where large boilers are the rule. In this article the writer proposes to trace the relation between the size of the boiler and the power developed by the locomotive.

Before proceeding any further, it may be as well to review briefly the conditions under which the locomotive boiler has to work. In the first place, owing to restrictions of space and weight, it must be an enormously rapid steam generator. This necessitates a large area of heating surface compared with the amount of water carried in the boiler. Secondly, owing to the small space available for the grate, a high rate of combustion must be maintained. This latter condition is rendered possible by the action of the blast-pipe, and also by the very efficient circulation promoted by the vibration of the engine. It is impossible to get the same rate of combustion on land boilers as on locomotives, owing to the water being unable to take up the heat sufficiently quickly, the result being unequal expansion, local overheating, and consequent leakage. It is this very efficient circulation which, by enabling the water to take up the bulk of the heat offered, maintains the efficiency of the locomotive boiler at a level vieing with the best land and marine boilers in spite of the distinctly unfavorable conditions for economical fuel consumption.

In laying out the design of a boiler it will be found the leading dimensions are governed almost entirely by the wheel arrangment of the engine, and, in the case of large boilers, by the limits imposed by the loading gage. The length of the boiler must be considered in conjunction with the wheel-base. The front tube-plate is generally level with the back of the cylinders, and the length of the barrel is fixed, in the case of four or six coupled inside cylinder engines, by the amount of room required for the cranks. This generally necessitates the fire-box being sloped up at the back to clear the trailing axle, although, in the case of small engines with a short fire-box, it is sometimes feasible to drop the fire-box between the axles. The height of the boiler will be governed by the relation of its diameter to the size of the driving-wheels, although sometimes a boiler may have to be raised in order to get sufficient depth for the fire-box when the latter is carried over one of the axles, and the diameter of the wheels is large. The diameter of the boiler is generally as small as is consistent with obtaining sufficient room for the tubes, the number and diameter of which will depend on the heating surface required.

The power developed by a locomotive boiler is limited chiefly by the size of the grate, and by the maximum rate of coal consumption. As regards the latter point, through the kindness of Mr. S. D. Holden, the locomotive superintendent of the Great Eastern Railway, the writer was recently afforded opportunities of noticing the rate of firing on express trains, and as a result of his observations he is enabled to state that the rate of coal consumption reached as high a value as 150 pounds per square foot per hour for a period of 10 minutes, the average on a non-stop run of 90 minutes' duration being 90 pounds per square foot per hour. The size of the grate was 21.6 square feet, and the load behind the tender was 300 tons, the average booked speed being 45 miles per hour.

The amount of water required by a locomotive is usually stated as being from 22 to 30 pounds per indicated horsepower-hour, the rather excessive amount being generally credited to the very wet steam which the locomotive boiler is accused of supplying, some authorities stating that the dryness fraction is as low as 60 per cent. In order to obtain some light on this debatable point, the writer recently calculated the steam consumption from a set of indicator cards taken from an express engine, and, assuming different dryness fractions, plotted the cards on an entropy chart until the horsepower of the entropy diagram agreed with the horsepower of the actual card. As a result he found that the average wetness of the steam during admission did not exceed 10 per cent., even when working heavily with the regulator wide open. The steam consumption measured from the indicator cards varied between 16 and 18 pounds per indicated horsepower-hour, the higher figure being for a cut-off of 25 per cent., hence the water consumption to be debited to the cylinders would be about 19 pounds per indicated horsepower-hour. Nevertheless it is a fact that the water consumption, as measured from the tender, is from 22 to 25 pounds per indicated horsepower-hour, and hence it is necessary to see what becomes of the remainder. Some of the steam is used by the injectors and also by the brake, and a certain amount is wasted at the safety-valves, and there is also a loss of water at the injector overflow. Reckoning that the steam used by the injector is 1 pound for every 10 pounds of water fed into the boiler, which means 2 pounds per indicated horsepower-hour accounted for by the injector, and putting the supply to brakes, waste at safety valves, and injector overflow, at 10 per cent. of the total, say 2½ pounds per indicated horsepower, we have:

Steam used by cylinders per I. H. P. hour	=	19 lbs.
" " injector per I. H. P. hour	=	2 "
" " brakes, etc.	=	2½ "
Total		23½

As, however, the chief demand made on the boiler while running is that of the engine, the brakes and safety valve losses only occurring, as a rule, when steam is shut off, we shall be justified in assuming that the average call for steam is 21 pounds per indicated horsepower.

The evaporative power of the boiler is generally given in pounds of water evaporated from feed temperature per square foot of heating surface per hour, and depends on the rate of coal consumption and the ratio of heating surface to grate area. This ratio varies between 60 and 100, the average being from 75 to 80. With a ratio of less than 60, the flue area will probably be so much reduced as to require a sharp blast, as was exemplified in the oft-quoted experiments on the French boiler, in which it was shown that for the same coal consumption the evaporation was approximately the same with half the tubes plugged up as with all the tubes open. It does not generally seem to have been noticed, however, that from 50 to 80 per cent. more draft was required to maintain the same coal consumption when half the tubes were plugged up. As regards the upper limit of the ratio, viz., 100, if this is obtained by crowding the tubes together or by making them of abnormal length, the advantage will be more apparent than real. Crowding the tubes together obstructs the circulation of the water, and abnormal length will result in increased frictional resistance for the hot gases, and in addition the last foot or two of length is not of much heating value, owing to the reduced temperature of the gases. In the following investigation the ratio of heating surface to grate area will be taken as 75; that is to say, the heating surface is 75 times the grate area.

Before proceeding any further, it will be as well to calculate the amount of water evaporated per pound of coal, and to do this we will assume that the steam pressure is 170 pounds gage, the dryness fraction 0.9, the feed temperature 60 degrees F., and that the boiler efficiency is 70 per cent., with coal having a calorific value of 14,000 British thermal units.

From the steam tables the sensible and total heats of steam at 170 pounds gage, when evaporated from water at 60 degrees F., are 348 and 1136.3 British thermal units, respectively, so that the heat required to evaporate 1 pound of steam of 0.9 dryness,

$$= \frac{1136.3 \times .9 + 288}{10} = 1051.5 \text{ B. T. U.}$$

and the water evaporated by one pound of coal

$$= \frac{14{,}000 \times .7}{1051.5} = 9.3 \text{ pounds.}$$

If C be the coal consumption per square foot of grate per hour, then the evaporation per square foot of the heating surface per hour

$$= E = \frac{9.3 \times C}{75} = 0.124 \times C \text{ pounds.}$$

As the power exerted by a locomotive is generally given as so many pounds tractive force at a certain speed, it will be convenient to reduce the boiler power to its equivalent tractive force. To do this, it will be necessary to assume that the rate of evaporation is constant, although, strictly speaking, this is not the case, as the power of the boiler increases with the blast of the engine.

Let T be the cylinder tractive force in pounds.
I. H. P. be the cylinder indicated H.P.
V be the velocity in miles per hour.

$$\text{Then } T = \frac{\text{I. H. P.} \times 33{,}000 \times 60}{5280 \times V} = 375 \frac{\text{I. H. P.}}{V} \quad . \; . \; . \quad (1)$$

If the grate area be denoted by G, we have, taking the steam consumption at 21 pounds per I. H. P.

$$\frac{G \times C \times 9.3}{21} = \text{I. H. P.} \quad . \; . \; . \; . \; . \; . \quad (2)$$

substituting for I. H. P. in (1)

$$T = \frac{375 \times G \times C \times 9.3}{21\, V} = 166 \frac{G \times C}{V} \quad . \; . \; . \quad (3)$$

If H represents the heating surface, then (2) becomes

$$\frac{E \times H}{21} = \text{I. H. P.} \quad . \; . \; . \; . \; . \; . \; . \; . \quad (4)$$

E being as before the evaporation per square foot of heating surface per hour. Substituting (4) in (1) we get

$$T = \frac{375 \times E \times H}{21 \times V}$$

$$= \frac{375 \times 0.124\, C \times H}{21 \times V}$$

$$= 2.21 \frac{C \times H}{V} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (5)$$

By introducing a factor, say, .85, representing the mechanical efficiency of the locomotive, and assigning a suitable value to C, we shall obtain expressions giving the available tractive force at the rails. For instance, if the maximum coal consumption be put at 120 pounds per square foot of grate per hour, then

$$T_1 = 0.85\ T$$

$$= (0.85 \times 166 \times 120) \frac{G}{V}$$

$$T_1 = 16{,}930 \frac{G}{V} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (6)$$

$$T_1 = (0.85 \times 2.21 \times 120) \frac{H}{V}$$

$$= 225 \frac{H}{V} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (7)$$

where T_1 is the available tractive force.

In order to find the load that can be hauled, divide the tractive force as given by the resistance per ton at the required speed, and the quotient will give the gross load in tons. By inverting V and T_1 as the total resistance of the train, we can determine the velocity that will be acquired. At low velocities the tractive force as found above may exceed the tractive force of the engine as found in the usual way; of course, the lower value should be taken.

As a numerical example let us take the case of an express engine working a train at a speed of 60 miles per hour on the level, and suppose that the engine has a grate area of 20 square feet, and that the weight of the engine and tender is 90 tons. Then, taking Eqn. (6), we have as the total tractive force

$$T = 16{,}930 \frac{G}{V} = \frac{16{,}930 \times 20}{60} = 5{,}643 \text{ lbs.}$$

At a speed of 60 miles per hour the resistance per ton is about 16 pounds.

$$\text{Hence the gross load} = \frac{5{,}643}{16} = 353 \text{ tons}$$

and the net load behind the tender will be 350 — 90 = 263 tons approximately, equal to twenty six-wheeled vehicles. Such a load would probably be as much as an engine having 18-inch by 26-inch cylinders could manage, especially if a side wind was blowing.

The chief value of the big boiler lies in the fact that it carries so large a bulk of hot water that, should the steam pressure show a tendency to fall when nearing the top of a long bank, the feed can be shut off, thus temporarily increasing the boiler power by some 25 per cent., owing to the fact that the latent heat of evaporation only has to be supplied. With the modern big boiler some 3 or 4 miles can be run with the feed shut off without letting the water level drop dangerously low.

For a similar reason it is advisable not to sacrifice water space to heating surface in engines which have to stop and start frequently. Such engines generally need to accelerate the speed rapidly, and it is of great use to be able to hold the injector off until the speed has been attained and the boiler can be filled up as soon as steam is shut off, thus preventing the safety valves from lifting.

In conclusion, the writer would emphasize the fact that such calculations as the above must not be regarded as rigidly correct, as the conditions under which the locomotive works are continually changing. At the same time the numerical constants inserted in the formulæ given above are such as to give loads which are within the power of an engine under distinctly adverse circumstances.—*C. Hugh Sumner in the Engineering Review.*

INCREASING USE OF SUPERHEATERS

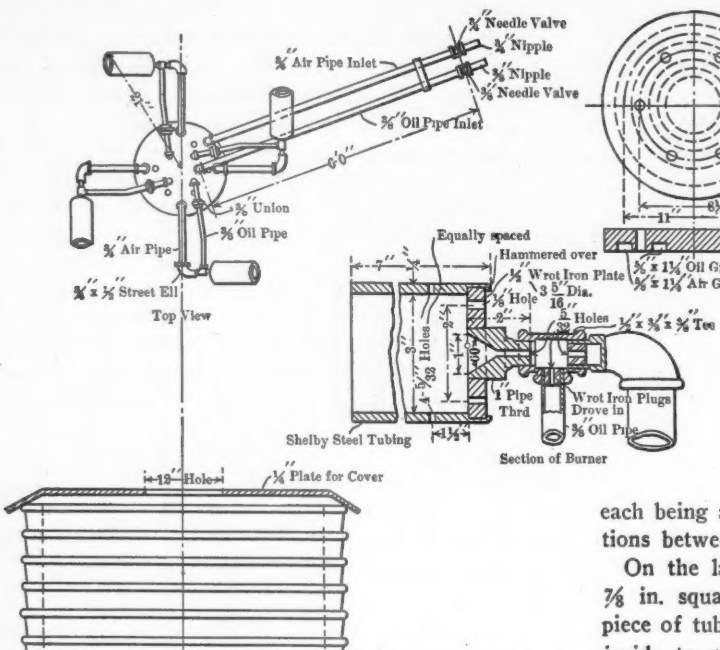
In 1901 the Canadian Pacific introduced the use of superheated steam on locomotives in America and nearly 500 Vaughan Horsey superheaters are now in service on that road. The Atchison, Topeka & Santa Fe, with 168 locomotives thus equipped, comes second in the list of twenty roads in this country now trying out a total of eight types of superheaters. The Schmidt superheater is used on 130 railroads in Europe, applied to over 5,000 engines. The adoption of superheaters in this country has, on the other hand, been along more conservative lines, notwithstanding the fact that nearly all the roads using them report a material saving in coal and at least half the number find no increased cost in running repairs. The most serious trouble experienced has been in leaky gaskets and filling of front end and flues with cinders.

The question of the amount of superheat is a most important one. The Purdue tests have shown that the first 80 to 100 degrees superheat do not make the same proportional decrease in coal consumption as do the second 80 or 100 degrees. European practice is to superheat until the temperature is 500 to 600 degrees Fahrenheit or over, in fact, as high as possible, and still maintain good lubrication, with forced lubrication for the balanced piston valves. This general practice applies to simple and to compound locomotives; in both cases the attempt appears to be to prevent condensation in the cylinder. This makes an expensive construction to maintain, and it has not met with favor in this country.

THE ORDER OF THE HARRIMAN LINES for 196 freight locomotives to cost about $4,000,000, and which was placed with the Baldwin Locomotive Works in Philadelphia, has created much favorable comment and is looked upon as the beginning of more liberal equipment purchases on the part of the railroads. In itself it is one of the largest locomotive orders ever placed at one time and will keep the Baldwin plant busy for some time

AN EFFICIENT TIRE HEATER

The accompanying illustration shows the detail construction of an oil heater which has been constructed at the West Springfield shops. It has been installed on the floor of the shop, where the tires can be handled by the cranes, and in close proximity with the drawing wheel gang.



TIRE HEATER DETAILS.

It consists of a base built up of two plates properly grooved, to which are connected the air and oil pipes of four burners, as well as two supply pipes. These burners are of simple and efficient construction, which is clearly shown in the illustration. They give an intense heat and a very large flame, which will heat a bank of eight tires very rapidly.

AIR DRIVEN FLUE CUTTER AND ROLLER

A machine which will permit the cutting out of one flue per minute in the front end of a locomotive, requiring the services of but one man, is in use at the Readville shops, and is shown in the accompanying illustration.

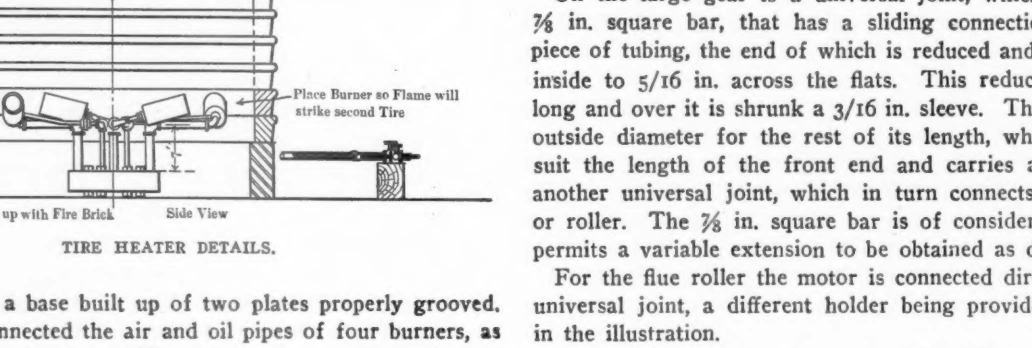
The apparatus is carried by a 2½ by ¾ in. bar about 78 in. long, which is provided with a number of ¾ in. holes in addition to a 10 in. slotted opening of the same width at one end. This bar is secured across the front end ring and carries the weight of the motor and gearing. Three gears are provided, the one connected to the motor having 18 teeth, which meshes with a 28 in. gear, which in turn meshes with a 148 tooth gear, each being a 1 in. face, giving a ratio of about 1 to 8½ revolutions between the cutter and the air motor.

On the large gear is a universal joint, which connects to a ⅞ in. square bar, that has a sliding connection with a long piece of tubing, the end of which is reduced and squared on the inside to 5/16 in. across the flats. This reduced end is 5 in. long and over it is shrunk a 3/16 in. sleeve. The tube is 1¾ in. outside diameter for the rest of its length, which is varied to suit the length of the front end and carries at its other end another universal joint, which in turn connects the flue cutter or roller. The ⅞ in. square bar is of considerable length and permits a variable extension to be obtained as desired.

For the flue roller the motor is connected directly to the first universal joint, a different holder being provided, as is shown in the illustration.

When this apparatus is arranged in the front end a small clamp is secured to the throttle of the air motor and the rod carried forward permits one man to either cut or roll the flues.

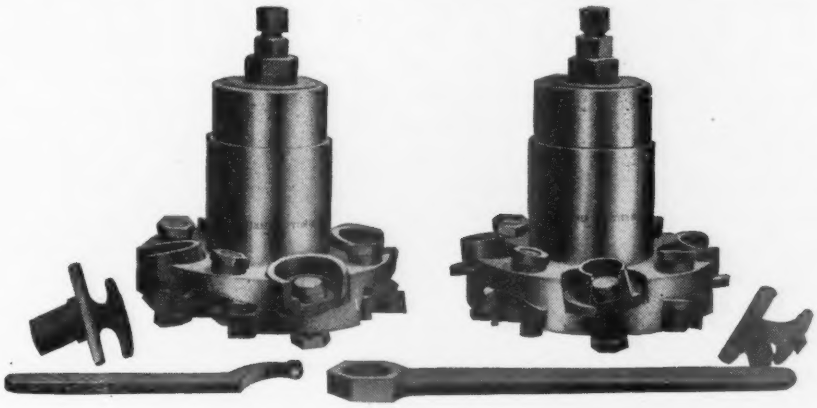
MOTIVE POWER FOR PANAMA CANAL.—Instead of the familiar old towpath mule giant electric locomotives will move the shipping through the Panama Canal locks. The ordinary locomotive would spin its wheels wildly and ineffectively upon the usual form of steel rail when its drawbar felt the weight of a twenty-thousand-ton warship, but the big electric locomotives will be geared to the tracks by a middle rail cut into the form of a rack giving enormous tractive power.



DETAILS AND ARRANGEMENT OF VERY EFFECTIVE FLUE CUTTER AND ROLLER.

A NEW CUTTER HEAD

The user of every high speed matcher is interested in the production of flooring at the lowest price consistent with good work. He feels the necessity of procuring tools and appliances that will not only do good work, but also such as will add convenience for the workmen, with genuine labor-saving advantages. Herewith is illustrated the "Shimer Limited" Cutter Head, manufactured by Samuel J. Shimer & Sons, Milton, Pa., the latest members of the large family of cutter heads on the market.



THE "SHIMER LIMITED" CUTTER HEADS.

In construction this head closely resembles the regular "Up-to-Date" and "Best of All" Cutter Heads which have been the standard tools for several years, but differs therefrom in the method of attaching them to the spindle; in the construction of the bit seats and of the bit designed for faster cutting; in the greater strength of the holding bolts, and especially in the self-centering device which clings to the spindle when drawn up, securing it firmly thereto. The spindle gripping device is positive and effective in its purpose of holding fast to the spindle, as also in centering the head for a more uniform action of the cutters. This is accomplished by having the central bore of the head tapered and having a rotatable cap and nut fitted in the upper portion. Into this bore a taper collet projects, having an upper threaded portion fitting the rotatable nut. When the top nut is drawn up the collet contracts and binds itself firmly to the spindle. This device is simple and effective and one not likely to get out of order.

To match flooring at the rate of 150 to 170 lineal feet per minute the side heads must be in perfect balance and the bits must be jointed. The foregoing description has shown that the heads are bound to be perfectly centered, and for the jointing the manufacturers provide a practical hand jointing machine. These heads are made either solid or with the expansion feature as may be preferred. All cutters are preferably made of high quality tool steel tempered to file. They hold an edge for any hard lumber for five hours and in many instances for a ten-hours' run.

The Value of an Apprenticeship.—There is nothing that will ever take the place of an apprenticeship. There is no trade school or training school in the country that will turn out young men or boys who are capable of entering a shop and competing with the average mechanic; while they may be taught considerable "book learning," their practical instruction must, of necessity, be limited. There is nothing that will take the place of practical experience. Manual training in our public schools may bring out the talent, may display the genius, but the fraternities and sororities of our high school system have made too many boys, who are natural born mechanics, "shun" the actual work, and dread the thought of an apprenticeship, it not being in keeping with the social and snobbish ideas gained from the fraternities and sororities while passing through high school.—*F. W. Thomas, Supervisor Apprentices, A., T. & S. F. Ry.*

VALUE IN FRONT END SPARKS

Considerable interest attached to the experience of the Prussian State Railway authorities in the utilization of the smoke-chamber waste from their locomotives. This waste consists of the particles of unconsumed fuel drawn by the strong draught from the fire-box through the tubes, and then deposited in the smoke box beneath the funnel. The product, which varies in size from a grain of sand to a hazelnut, is really hard coke, and was previously thrown on heaps to be sold at low prices for use in road construction. Attempts to employ it as fuel were not successful even when it was made into briquettes with tar, but very satisfactory results are now being obtained by distilling it, employing the gas so produced in gas engines and converting the power into electricity. The Prussian State Railway has already six plants working, and the other German railways are following suit. It is estimated that the Prussian railway system will obtain 160 million kilos of the waste coke annually, capable of generating 25,000 horsepower daily. The actual cost of the electricity—without allowing for depreciation and interest on capital outlay—is calculated at about three pfennigs, say one-third of a "penny" (two cents) per kilowatt-hour.

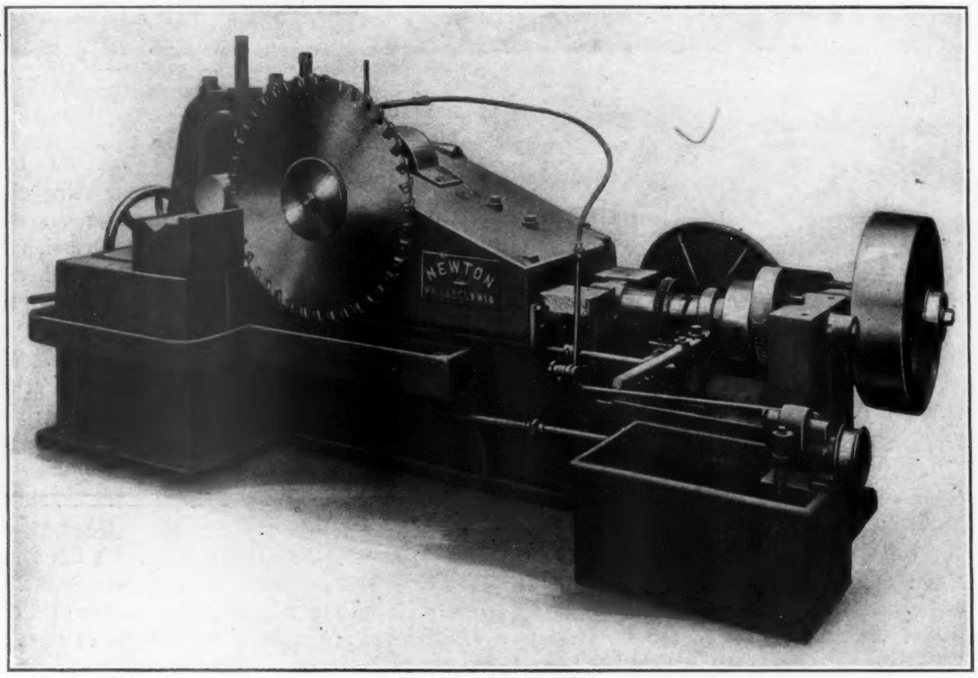
Freight Train Resistance: Its Relation to Car Weight, by Edward C. Schmidt, has just been issued as Bulletin No. 43 of the Engineering Experiment Station of the University of Illinois. This bulletin presents the results of tests made upon 32 freight trains in regular service, in order to determine their train resistance. These tests were undertaken to study the effects upon train resistance of both speed and the average weight of the cars composing the train. The results show the usually accepted influence of speed upon resistance, and they reveal a still greater influence of average car weight in effecting changes in resistance. For trains composed of care weighing 15 tons, on the average, the resistance is shown to vary from 7½ lb. per ton at 5 miles per hour to 13½ lb. per ton at 40 miles per hour; while for trains composed of cars weighing 75 tons, the resistance is shown to vary from 3 lb. per ton at 5 miles per hour to 5½ lb. per ton at 40 miles per hour. Copies of Bulletin No. 43 may be obtained gratis upon application to W. F. M. Goss, Director of the Engineering Experiment Station, University of Illinois, Urbana, Illinois.

New Shops for the Boston and Maine.—The general repair plant for which the Boston and Maine now is seeking a site will cost about $3,000,000 above the land and will employ several thousand men, with the possibility of still greater development in years to come. The buildings will be of the most approved fireproof construction and will be intended to take care of the bulk of the locomotive and car repair work on all of the Boston divisions, so for that reason it must be conveniently situated with reference to accessibility from Boston.

COLD SAW CUTTING OFF MACHINE

The constantly increasing demand for metal sawing or cutting machines and the value of equipment of this kind in all metal manufacturing plants, singularly enough does not appear to be realized by a great number of manufacturers. For instance, many plants have lathes in operation cutting up shafting, bar stock, gear blanks and the still slower method of slotting flats, such as locomotive rods, valve gears, etc.

The Newton Machine Tool Works, Inc., of Philadelphia, Pa., has devoted considerable study to the development of this appliance, and in their new design herein illustrated have produced a machine with which feeds are now obtained equal to five times that obtained by the old design of machines. In their time these latter were amply heavy to drive the solid tooth blades then used to their maximum efficiency. However, with the introduction of high speed cutting steels, and their incorporation in cold sawing equipment, the blades now being known as inserted tooth high speed saw blades, the advantages in high productive capacity of cold sawing machines was quickly realized. For instance, a 12 in. square billet of .70 carbon was cut off in 10 minutes, and an 8½ in. diameter round billet of .45 carbon was cut off in 6½ minutes. Two rod cuts have been made with the new machine 12 in. deep with the rod 5 in. thick, and the time of cutting only 17 minutes. While this is slightly excessive, many forges are obtaining feeds of from ¾ in. to 1 in. per minute on a large proportion of their output. These cuts referred to are not, however, presented as speed tests, but to demonstrate the steady, even motion of the best obtainable, or inserted tooth saw blades, when used on Newton machines.



POWERFUL NEWTON METAL SAW.

In the construction of the modern machines to obtain this output only the best of materials, the most accurate fitting in construction, and the heaviest and well braced castings are used. There is only one important bracket on the machine, and this carries with the bearings for both of the only two shafts that have opposed stresses. The design of every machine must adhere to specifications similar to the following:

Spindles finished by grinding, fitted to the saddle by hand scraping, and the pinion driving the spindle gear to have the teeth cut from the solid shaft. The spindle to revolve in capped bearings, to compensate for wear, to be supported at both ends and to be equal in length over all to the diameter of the saw blade, and the driving gear to be mounted between the end brackets. The worm wheel shaft, from which the teeth of the driving pinion are cut, carries a solid bronze worm wheel with teeth of steep lead, the angle calculated to operate with the minimum amount of power lost through friction, which is actually less than spur gear driven machines on account of a few connections. The driving worm to be hardened and fitted with roller thrust bearings, both these and the worm wheel to be encased for continual lubrication, and the horizontal driving shaft to have a bearing on each side of the driving worm. The bearings for the worm wheel and driving worm shafts to be cast solid with the saddle in order that all stresses may be self-composed, and all bearings to be bushed where necessary. The machine to have constant friction feed, variable in rate, with power quick return and hand adjustment.

All operating levers to be placed conveniently to facilitate the maximum output by decreasing the idle time of the machine, and the feed screw to have a bearing at both ends to permit of this always being maintained in tension. The spindle saddles to be of heavy boxed type construction, to have a bearing the full width and full length of the saddle on the bed of the machine, with underlocking gibs cast solid and adjustments made by means of taper shoes and square sheer bearings on the saw side. The saddle to be fitted to the sheers by hand scraping and to be fitted with dogs for tripping the positive safety release for each of the extreme positions of the saddle, and also the adjustable automatic release to the feed, and in order to facilitate the operations on broad or angular work, the hand wheel to be fitted on the squared end of the adjusting screw. The base of the machine is one solid casting and comprises the bearings for the saddle and the supports for the driving mechanism in addition to the work table which has "T" slots cut from the solid, and the pans for the lubricating system are also cast solid. The base and outer bracket to have finished pads to permit of changing the machine from belt to direct motor drive by simply bolting on the motor bracket, as the attaching faces are finished before shipping the machine, whether the machine is sold for belt or motor drive, and all machines to be furnished complete with pump, piping and attachments for lubrication, as experience has proven that to be effective all heat-absorbing and lubricating materials must be delivered at the point of cuting. Especially is this true on the inserted high speed saw blades.

This design of machine is practically self-contained. It occupies little floor space, and on account of the few parts used and the attention to the best combinations of metal for the transmitting gears, a very low maintenance cost is obtained, especially in saw blades, as there is no jar or chatter to the drive, and any

unequal pressures are gradually taken up by the angle of the worm and worm wheel.

At the time of designing the older type of machine a cold saw cutting off machine was thought to be of a very rough nature, to be operated by unskilled help, and while the present type of machine requires no skill for its operation on account of its simplicity, much better results can be obtained by operators having at least some knowledge of mechanics, as one so familiar pays better attention to securely clamping the work, a neglect of which causes 80 per cent. of the complaints on equipment of this description. The chief consideration of the development of these machines is based on the fact that a cold saw to-day is a machine tool on which the sawing is in reality a milling operation, and operates under considerations much more delicate than encountered in the operation of the horizontal or knee type milling machine on account of the large diameter and necessarily narrow width of the blades.

COLBURN HEAVY DUTY DRILL PRESS

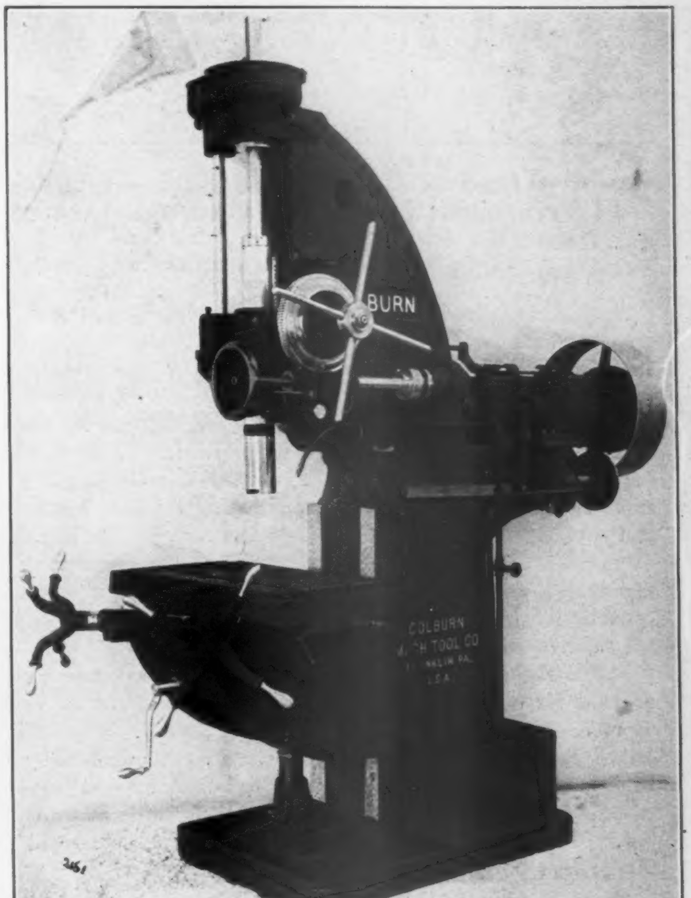
It is a well-known fact in connection with the general development of machine tools which has been a prominent feature of recent years that the faithful and indispensable drill press was probably the last to receive attention. The drill presses of only twenty years ago were crude and unsatisfying, that is, at least so far as confined to railroad shops. They were not designed to meet the equal requirements of strength and rigidity within reasonable compactness, and they either embodied an unwarranted overplus of stock, or such a lack of it as to prevent anything like a wide operating range.

No greater contrast can be afforded than in the comparison of this useful machine in its modern form with the many makeshifts of the past. This 24-inch heavy duty drill press by the Colburn Machine Tool Co., Franklin, Pa., well illustrates the attention which is now being given the appliance and the high development to which it has attained. The drill press properly understood has ceased being merely a machine for drilling holes and has come to be recognized as a productive tool of much importance.

The effective arrangement of detail in the drill press herein illustrated is particularly pleasing. No cast iron gears whatever are used in the machine, all being made of steel forgings or manganese bronze castings, and all gears in the speed box and feed box run in a bath of oil. The main driving gears on the spindle are helical, and can be driven at a much greater speed than spur gears with the elimination of any tendency to chatter. The spindle is of forged high carbon steel, with the thrust taken on Hess-Bright ball thrust bearings which withstand the most severe duty without injury. The spindle has a travel of 16 inches, and has a No. 5 Morse taper at the bottom.

Feed changes are obtained through positive gears running in an oil-tight box, the changes being made by means of a drive key and back gears. The feeds are six in number, varying in geometrical progression from .009 to .060 per revolution of the spindle. Direct feed on the spindle is through a large diameter worm gear carrying a graduated dial reading in thirty-seconds of an inch that enables the operator to accurately measure the depth drilled. This dial is provided with an adjustable pawl which can be set to automatically trip the feed at any point up to 14 inches travel of the spindle. The feed may also be tripped by hand from the operator's position. All the gears in the feed box run in a bath of oil and all bearings have positive lubrication.

The compound table, shown with the machine illustrated, is furnished only when specially ordered and is probably the most interesting feature in connection with this handsome and exceptionally well designed drill press. It is not an attachment to the regular table, but consists of a special knee with a table having a rapid movement through spiral worm and rack of 20 inches longitudinally, and 8 in. crosswise. Capstan handles are so arranged that the operator standing directly in front of the machine can manipulate the table in both directions without moving from his position. So rapidly can these adjustments be made that the drill will reach any point within the area of the table surface in less time than it takes to adjust the ordinary round drill press table. It is impossible for this compound table to spring in the slightest degree, as the massive knee and telescopic screw effectually resists this tendency. A large oil pocket is cast on each side of the table, and a cored opening running entirely through the table drains the lubricant from the



HEAVY DUTY DRILL PRESS.

left to the right hand jacket and from here it is piped through a flexible tube back to the tank. The working surface of the compound table is 16 by 30 in.

The drive consists of an oil-tight box containing all the gearing from which the spindle speeds are obtained, and is driven by a single friction clutch pulley, and no countershaft is required. All speed changes are made by two levers at the front of the machine. This machine has a capacity to the full cutting edge of 2½ in. high speed drills in solid steel. Its net weight with plain table is 4,000 lbs., and with compound table, 4,400 lbs.

A NEW WHITE METAL ALLOY called "Atherium" has recently been brought out, for which the following properties are claimed: It is lighter than aluminum, the specific gravity being 2.4 to 2.57, according to the mixture. The alloy has a tensile strength of 18.66 tons per sq. in. A test made by R. H. Harry Stanger, of Westminster, on a test piece of 0.628 in. in diameter showed an elastic limit of 33,712 lb. per sq. in., and an ultimate strength of 41,798 lb. per sq. in. The extension in 2 in. was 17.5 per cent., and the reduction of area was 39.1 per cent. The alloy makes good sound castings, and works well in rolling and turning. Clean screw threads can be cut, and it can also be soldered, forged and welded. It does not tarnish or corrode, and withstands the action of sea-water. It is also electrically positive; the conductivity is about 55.1.

The Railroad Clubs

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	Feb. 7	The Generation and Distribution of Electric Power and Its Application to Railroads	Z. Darlington	Jas. Powell	P. O. Box 7, St. Lambert, near Montreal
Central	Mar. 10			H. D. Vought	95 Liberty St., New York
New England	Feb. 14	Impressions of English Railway Service	W. J. Cunningham	Geo. H. Frazier	10 Oliver St., Boston, Mass.
New York	Feb. 17	The Application of the Wireless Telegraph as an Aid in the Operation of Railroads	F. H. Milliner	H. D. Vought	95 Liberty St., New York
Northern	Feb. 25			C. L. Kennedy	401 W. Superior St., Duluth, Minn.
Pittsburgh	Feb. 24	The Conservation of Human Life in Steam and Electric Railroad Travel	G. P. Thurber	C. W. Alliman	P. & L. E. R. R., Gen. Office, Pittsburgh, Pa.
Richmond	Feb. 13	—		F. O. Robinson	C. & O. Ry., Richmond, Va.
Southern	Apr. 20			A. J. Merrill	218 Prudential Bldg., Atlanta, Ga.
St. Louis	Feb. 10			B. W. Frauenthal	Union Sta., St. Louis, Mo.
Western	Feb. 21				890 Old Colony Bldg., Chicago
Western Canada	Feb. 13			W. H. Rosevear	199 Chestnut St., Winnepeg, Man.

THE EVOLUTION OF AIR BRAKES MADE NECESSARY TO MEET MODERN TRAIN CONDITIONS

NEW ENGLAND RAILROAD CLUB.

H. N. Lamb, mechanical instructor, railway department, of the International Correspondence Schools, Scranton, Pa., presented at the December meeting of the above club a very interesting paper on the development of the air brake, and its further possibilities. Mr. Lamb points out forcibly that the installation, care and maintenance of the air brake is of greater importance than some roads seem to regard it, and, though vast sums of money may be spent in purchasing the best equipment and applying the same to locomotives and cars, yet the efficiency of the brake will not be maintained unless the brake itself is maintained, and this can only be properly done by a thorough organization of the air brake department of the railroad under the supervision of competent and up-to-date men.

Those who are of an inventive turn of mind will find plenty of food for thought in the future development of the air brake to more properly meet the conditions of to-day. The author claims that the present brake, efficacious as it undoubtedly is, has not yet reached perfection; that it cannot be said there is nothing more to be accomplished along these lines, as to-day a brake is needed with the following features not possessed by the present equipment:

First, a brake that will automatically increase the braking power of a car in proportion to its loaded weight; second, a cheap and practical coupling for air brake hose or pipe that will couple and uncouple without damage when the train breaks in two; third, a practicable brake for freight cars capable of being gradually released; fourth, some signal or means through which an engineer can ascertain if all brakes in his train have released; fifth, a practical brake for freight cars whose efficiency will not be affected through cylinder leakage; and sixth, a brake which will quickly recharge, thereby eliminating the use of retainers.

This paper in general may be regarded as an extremely valuable addition to air brake literature. It is well written and will well repay an attentive perusal.

LUBRICATION OF HIGH PRESSURE SLIDE AND PISTON VALVE LOCOMOTIVES

CENTRAL RAILWAY CLUB.

This always interesting subject was accorded a decidedly novel treatment in a short, but none the less instructive paper, presented by W. O. Taylor before the above club at its January meeting. In the premises the author contends that, despite opinions to the contrary, if the lubricant is properly introduced and distributed with the steam the pressure and temperature of the steam are factors of but little importance. To this end it is advocated that the oil be delivered into the steam at a point where it can be thoroughly intermingled with the steam before the latter reaches the steam chest or valve chamber, and through the thorough lubrication of the steam secure similar lubrication for every point with which it comes in contact.

Mr. Taylor said that it has been demonstrated beyond question that the cylinder oil in general use is efficient under all steam pressures and temperatures yet obtained in locomotive operation, and that it has been further demonstrated that locomotives using superheated steam, where the maximum temperature does not exceed 500 degrees F., do not require any more oil for valve and cylinder lubrication than the same locomotive using saturated steam. It is further claimed that conditions are more favorable for satisfactory and economical lubrication when superheated steam is used and that less oil is required. The absolutely dry condition of the steam entirely obviates the flushing of valves and cylinders with the consequent washing away of the lubricant. The paper concludes with several interesting references to actual service performances in support of the author's contentions.

CHRISTMAS ENTERTAINMENT

NEW YORK RAILROAD CLUB.

The December meeting of this club was devoid of the usual paper, but it was none the less an enjoyable occasion to a formidable array of members and their guests who journeyed from far and near to attend what has in reality come to be considered as a general annual reunion. The feature of the short session was the presentation to W. G. Besler, the retiring president, of a handsome silver pitcher, after which an adjournment became in order to the large auditorium of the Engineering Societies Building where the usual liberal vaudeville entertainment was provided. An elaborate supper terminated the thoroughly enjoyable evening.

SOME PERTINENT FEATURES RELATING TO GAS POWER

RAILWAY CLUB OF PITTSBURGH.

At the November meeting of this club an able paper on the above subject was presented by Edwin D. Dreyfus, commercial engineer of the Westinghouse Machine Co., Pittsburgh. In the admitted breadth of this important subject it has been impossible to give due emphasis to the variety of factors and conditions that individually are deserving of lengthy discussion. The author has endeavored, however, for the benefit of the club members before whom it was read, who have not in any way identified themselves heretofore with this phase of engineering, to direct their attention to its fundamental features without introducing complex or elaborate theory and descriptions.

BOOK NOTES

The Practical Engineer Pocket Book and Diary for 1911. Published by the Technical Publishing Co., Limited, 55 and 56 Chancery Lane, London, W. C. 702 pages, 3½ x 5½. Illustrated. Price, 36c.

The demand during 1910 for The Practical Engineer Pocket Book is said to have eclipsed all past records, the book being dispatched to every part of the world. Although much obsolete and less important matter has been stricken from past editions, the book now before us contains over 700 pages of matter which has been most carefully selected in order to present a book having the maximum of utility. The new matter includes Notes on Stoker Systems, Calorimeters, Fuel Economisers, Thermal Storage, Superheaters, Bearing Pressures, Recent Practice in Ball and Roller Bearings, Cup Leathers, Chain Drivings, the Magnetic Clutch; also Pyrometry, Pneumatic Tools and the Extensometer; Tables of Flange Dimensions, Pinion and Music Wire, Zinc and Lead Gauges, Solders and Alloys. Revisions have been very extensive, and affect such articles as Accurate Gauging in the Shop, Pattern Allowances for Machinery, Belt Factors, Gas and Oil Engine Ignition and Tests, Water Turbines, etc., etc. The book is fully indexed and contains a diary of 64 pages.

Railway Management at Stations. By E. B. Iratts. Cloth, 605 pages, 5 x 8 inches. Published by McCorquodale & Co., Ltd., Cardington St., Eaton Square, London, N. W. Price, $2.50, of Van Nostrand Co., New York, N. Y.

This book, which is now passing through the fifth edition, has been in circulation for over 20 years, and by its continued sales appears to have met an appreciative demand in this country, although its scope is necessarily confined to British practice. It deals most comprehensively with station work and management, reviewing in detail the features of organization, discipline, canvassing for traffic, acceptance and delivery of goods, accounts and legal claims. Mr. Iratts' long experience as goods or freight manager of the Midland Great Western Railway qualified him to discuss these important questions from an authoritative standpoint, therefore the book becomes of exceptional value for reference in the interpretation of many puzzling details which continually arise in connection with such work. The chapters on the arrival and departure of passengers and the handling of parcels and baggage are very interesting, despite their foreign setting, and the fact that only a very large terminal is under dissection. The book also contains sections of acts of parliament in relation to railroads which are very conveniently arranged for reference. Not the least interesting feature in connection with this valuable work is an extensive glossary of railway terms in which the different nomenclature between that country and our own for the same object or operation is forcefully illustrated.

Proceedings of the Master Car Builders' Association. Forty-fourth Annual Convention. Atlantic City, N. J., June 15 to 17. Published by the Association. J. W. Taylor, Secretary, 390 Old Colony Building, Chicago.

The subjects reported upon and discussed at this convention were of unusual importance, and their compilation in detail as herein presented renders this report a most valuable addition to the forty-three volumes which have preceded it during the life of this association. Among some of these reports might be mentioned that of the standing committee on the Revision of Standards and Recommended Practice; Train Brake and Signal Equipment, constituting a thorough résumé of emergency brake tests made on the Lake Shore and Michigan Southern Ry. during October, November and December, 1909. In addition to its usual duty of investigating the properties of brake shoes the standing committee on brake shoe tests considered in its report, at the request of the executive committee of the association the standards applying to brake beams. No doubt at this time interest principally centers in the report of the committee on the consolidation of the two associations, and accompanying its report is the constitution of the proposed "American Railway Mechanical Association." The present report of the forty-fourth convention contains 849 pages, with the usual addition of many folding diagrams of M. C. B. standards.

Proceedings of the American Railway Master Mechanics Association. Forty-third Annual Convention, Atlantic City, N. J., June 20 to 22, 1910. Published by the Association. J. W. Taylor, Secretary, 390 Old Colony Building, Chicago, Ill.

The full report of the committees and the discussions thereon are given in this volume of 600 pages. Very valuable reports were given on the following subjects: Mechanical Stokers; Education as an Essential of Fuel Economy; Superheaters; Locomotive Frame Construction; Freight Train Resistance; Train Brake and Signal Equipment; Design, Construction and Inspection of Locomotive Boilers; Locomotive and Shop Operating Costs, and on Consolidation.

Proceedings of the Traveling Engineers' Association. Eighteenth Annual Convention, held at Niagara Falls, Canada, August, 1910. Leather, 392 pages, 6 x 9. Secretary W. O. Thompson, 820 Elmwood avenue, Buffalo, N. Y.

There is not a dull line in this admirably prepared and well-edited convention report, and a careful perusal of its pages must interest anyone in the locomotive world, irrespective of his position either on the road or in the shops. The Traveling Engineers are to be congratulated on the real value of the subjects selected for their conventions, and too much praise cannot be given for the able manner in which the various papers are prepared and presented. The paper on Superheat As Applied to Locomotives provoked a most instructive discussion in view of the timeliness of the subject. It covers some 90 pages of the report and constitutes a thorough review of what has been accomplished in superheating up to the present time. Fuel Economy was not lacking in equal interest, and was well discussed. There were other papers of great value, and on the whole it may be said that their compilation in this form constitutes a valuable addition to existing locomotive data.

Pocket-Book of Mechanical Engineering. By Charles M. Sames, B.Sc. Flexible leather, 4 x 6⅝ in. 220 pages. Illustrated. Published by Charles M. Sames. Price, $2.00.

This book is the result of the writer's endeavor to compact the greater part of the reference information usually required by mechanical engineers and students into a volume whose dimensions permit of its being carried in the pocket without inconvenience. It is a correct and up-to-date digest of mechanical engineering science, embracing the widest range of subject matter, and of exceptional value to designers of machinery, containing one of the most comprehensive collections of formulas, data and constants relating to the proportioning of machine parts, assembled machines and motors that is published in the English language.

The Westinghouse Diary for 1911. Published by the Westinghouse Electric and Manufacturing Co., Pittsburg, Pa. 96 pages, 2½ x 5.

This little book has made its welcome appearance replete with the usual tables and valuable reference matter which are indispensable to the engineer, and, in fact, to anyone directly or indirectly interested in the application of electricity. The portion devoted to the annual record or diary consists of 50 pages, followed by several pages for addresses and memoranda. An unique feature is the presence in the book of some 16 pages ruled as expense account forms.

PERSONALS

C. H. DOEBLER has been made master mechanic of the Chesapeake & Ohio at Peru, Ind.

CARL HILL has resigned as master mechanic of the Fitzgerald, Ocilla & Broxton Railroad.

E. S. EDEN has been appointed master mechanic of the Central New England Ry., with office at Hartford, Conn.

F. W. RHUARK has been appointed master mechanic of the Baltimore & Ohio R. R., with office at Lorain, Ohio.

J. E. HENSHAW has been made superintendent of the Frisco shops at Springfield, Mo., vice G. W. Lillie, resigned.

C. N. SWANSON has been appointed superintendent of the car shops at Topeka, Kan., Atchison, Topeka & Santa Fe Ry.

H. HONDSER has been appointed assistant master mechanic of the St. Louis & San Francisco R. R., with office at Memphis, Tenn.

J. DUGUID has been appointed master mechanic of the Grand Trunk Ry. at Montreal, Que., to succeed J. C. Garden, transferred.

D. H. SPEAKMAN has been appointed master mechanic of the Baltimore & Ohio R. R. at Benwood, W. Va. He succeeds A. Schaaf.

WILLIAM MYERS has been made assistant roundhouse foreman of the Atchison, Topeka & Santa Fe Ry. at Fort Madison, Iowa.

WALTER REID has been made road foreman of engines of the Santa Fe Ry. at San Bernardino, Cal., vice M. P. Cheney, promoted.

J. B. NEISH has been appointed master mechanic on the Northern Pacific R. R. at Minneapolis, Minn., succeeding Silas Zwight, transferred.

FRED VON BERGEN has been appointed air brake inspector of the Nashville, Chattanooga & St. Louis Ry., succeeding Otto Best, resigned.

H. A. SOUTHWORTH, division foreman on the Maine Central R. R. at Waterville, Me., has been appointed master mechanic at Portland, Me.

C. D. LIDE has been appointed master mechanic of the Georgia, Florida & Alabama Ry., with office at Bainbridge, Ga., succeeding J. D. Crawley.

R. COLLETT has been appointed superintendent of locomotive and fuel service of the St. Louis & San Francisco R. R., with office at St. Louis, Mo.

F. T. SLAYTON has been made superintendent of motive power of the Virginia Ry., with office at Princeton, Va., succeeding L. B. Rhodes, resigned.

SILAS ZWIGHT, master mechanic at Minneapolis, Minn., Northern Pacific R. R., has been transferred to Missoula, Mont., succeeding T. J. Cutler, resigned.

O. M. KNECHT has been appointed roundhouse foreman at Las Vegas, N. M., Atchison, Topeka & Santa Fe Ry., succeeding E. J. McMahon, transferred.

J. I. HALLER has been transferred from general roundhouse foreman, Susquehanna shop, Erie Railroad, to general foreman at the same point, vice L. R. Laizure, promoted.

H. M. BARR has been appointed master mechanic of the Sterling division of the Chicago, Burlington & Quincy Railroad, at Sterling, Colo., vice T. J. Raycroft, transferred.

G. C. BONEFELD has been appointed master mechanic of the United Railways of Havana, at Havana, Cuba, vice William M. Stokes, resigned to go to the Galena Oil Co. at Buenos Ayres.

WM. LEID, locomotive engineer of the Buffalo division, Erie Railroad, has been appointed road foreman of engines, with headquarters at Buffalo, N. Y., succeeding Charles Davis, deceased.

J. C. GARDEN, master mechanic of the Eastern division of the Grand Trunk Ry., at Montreal, Que., has been transferred to the Battle Creek, Mich., shops, vice J. T. McGrath, resigned.

W. J. MCGEE, master mechanic of the Tampa Northern R. R., at Tampa, Fla., has been appointed master mechanic of the International & Great Northern R. R., with office at Mart, Texas.

D. J. SULLIVAN has been transferred from assistant general foreman at Susquehanna shop, Erie Railroad, to general roundhouse foreman at the same point, succeeding J. I. Haller, promoted.

C. W. FROMM has resigned as foreman of the Chicago, Indiana & Southern R. R. at Kankakee, and has been made roundhouse foreman of the Chicago Great Western Ry. at Clarion, Iowa.

J. W. CYR, division master mechanic at Hannibal, Mo., on the Chicago, Burlington & Quincy R. R., has been appointed superintendent of motive power at Chicago, succeeding Mr. Torrey. promoted.

O. J. KELLY succeeds H. D. Van Valin as a master mechanic of the Baltimore & Ohio R. R. at Parkersburg, W. Va. He was formerly night roundhouse foreman at Susquenanna, Pa., on the Erie R. R.

W. A. HAMMEL has been appointed purchasing agent of the Atlanta, Birmingham & Atlantic Ry., with office at Atlanta, Ga., succeeding W. D. Knott, granted leave of absence on account of ill health.

T. J. RAYCROFT has been appointed master mechanic of the Alliance division of the Chicago, Burlington & Quincy R. R., with headquarters at Alliance, Neb., vice F. C. Stuby, assigned to other duties.

A. G. MCCLELLAN, formerly general foreman of the shops of the Grand Trunk Ry. at Battle Creek, Mich., has been made road master mechanic, a newly created office, on the Chicago & Alton R. R., with office at Bloomington, Ill.

T. J. POWELL, formerly tool foreman of the El Paso & Southwestern Ry., and the first president of the American Railway Tool Foremen's Association, is now foreman of the railroad shops of the Chino Copper Company, Santa Rita, N. M.

T. J. CUTLER, formerly master mechanic on the Rocky Mountain division of the Northern Pacific R. R. at Missoula, Mont., has been appointed master mechanic on the Idaho division, with office at Spokane, Wash., succeeding F. B. Childs, deceased.

OTTO BEST has resigned his position as air brake inspector of the Nashville, Chattanooga & St. Louis Railway, to enter the supply business. He has accepted a position with the Nathan Manufacturing Company of New York, and his headquarters will be in that city.

F. A. TORREY, superintendent of motive power of the Chicago, Burlington & Quincy lines east of the Missouri River, at Chicago, has been appointed general superintendent of motive power of the entire Burlington system, with office at Chicago, succeeding F. H. Clark, resigned to go to the Baltimore & Ohio.

DAVID VAN RIPER, until recently master mechanic of the Rochester division, Erie Railroad, with office at Avon, N. Y., died recently at his home in Meadville, Pa. Mr. Van Riper had risen from apprentice to master mechanic on the Erie, and had a full knowledge of the latter important branch of railroad service. Some months ago failing health compelled his retirement from the exacting duties of the position, and he was assigned to lighter work at Meadville.

L. S. CARROLL, purchasing agent of the Chicago & North Western R. R., has been appointed general purchasing agent of the North Western and the Chicago, St. Paul, Minneapolis & Omaha R. R., at Chicago, a new office, and his former title has been abolished. John Ball has been appointed assistant purchasing agent, with office at Chicago. Isaac Seddon, purchasing agent of the Chicago, St. Paul, Minneapolis & Omaha R. R., at St. Paul, Minn., retains his office and title and will report to Mr. Carroll.

CATALOGS.

"TURRET LATHE EXPERIENCE" is the title of a leaflet issued by the Gisholt Machine Co., of Madison, Wis., in which some interesting operations are illustrated of work performed in the Gisholt machines.

SINGLE PHASE INDUCTION MOTORS.—Bulletin No. 3141, issued by the Emerson Electric Mfg. Co., of St. Louis, Mo., is devoted to a description of the Type 7142 F. A. single phase induction motor of from 1/10 to 1/5 horsepower.

AIR COMPRESSORS.—The Ingersoll-Rand class A-1 compressor forms the subject of a pamphlet issued by that company from its office, at 11 Broadway, N. Y., which describes the compressor in detail and illustrates all of its principal parts.

"ELECTRIC AIR" ROCK DRILLS.—Under this title the Ingersoll-Rand Co., of 11 Broadway, N. Y., has issued an attractive little treatise of 24 pages, illustrating the range of work for which the Temple-Ingersoll "Electric Air" drill is particularly adapted. The apparatus is fully described with the assistance of many fine half-tone cuts.

Laboratory Lathes.—These interesting appliances are thoroughly described and illustrated in Bulletin 3708, issued by the Emerson Electric Mfg. Co., of St. Louis, Mo. The bulletin is of especial interest to the users of these tools, and the substantial design of the latter is quite appealing, in view of the fact that it is a point often lost sight of in the majority of foreign tools for similar purposes.

Spiral Riveted Pressure Pipe.—The American Steel Pipe Works, of Chicago, Ill., has issued a pamphlet showing a number of views of long lines of Taylor's spiral riveted pressure pipe, as applied in various mining and pumping installations. This pipe for a number of years has been standard for exhaust steam purposes, and is also especially adapted for water supply lines, suction and discharge, etc.

Leather Belting.—The December, 1910, issue of *Phoenix*, published by the New York Leather Belting Co., 51 Beekman St., New York, has for its two middle facing pages some 20 finely executed half-tones of the principal members of its energetic and efficient staff. The design and arrangement of the cuts is clever and the general appearance decidedly attractive. The *Phoenix* also contains its usual amount of valuable information for belt users, and is on the whole an artistic and valuable issue.

Boiler-Makers' Tools.—Under this title the J. Faessler Mfg. Co., of Moberly, Mo., has just issued a very complete 32-page catalog of boiler-makers' tools, all of which are illustrated and their various advantageous features clearly indicated. Considerable space in the book is devoted to roller and sectional expanders, and much valuable information is embodied. The Faessler flue cutting machine for locomotive boilers is of special interest, and in a very finely executed cut it is shown applied to a locomotive and ready for business. The prominence accorded the general question of boiler maintenance at this time renders a study of this catalog of particular interest.

Ball Bearings.—This interesting subject has been dealt with at length by the Hess-Bright Mfg. Co., of Philadelphia, in one of the handsomest and most comprehensive catalogs which has reached this office in many months. The work, as it can scarcely be designated by any other name, is in reality an engineering treatise on ball bearings, and constitutes the last word on the subject. The historical matter in connection is of the highest value, and reflects great credit to the painstaking work of the compilers in bringing to light such a wealth of interesting detail. The book contains 64 pages, 9 x 12 inches, and is profusely illustrated, several hundred superb cuts being embodied in the text. For reference, especially, and for general information on its theme it is unequalled by any book in the language.

Seamless Steel Tubing.—The National Tube Co., of Pittsburg, Pa., has devised a most effective and unique method of illustrating the above mentioned product. It consists of a large framed table, a reproduction of that shown at the St. Louis Exposition and at the various mechanical conventions, and which attracted much attention. The table, which is composed of hundreds of tubing sections, graphically illustrates the large variety of shapes into which the Shelby Seamless Steel Tubing can be formed. The pieces of tubing illustrated were not made for this specific purpose, but were taken from parts of tubing made to customers' orders. The design, which is handsomely framed, is encircled by some beautiful examples of workmanship, including watch charms and paper cutters. On the whole it is a decidedly novel and attractive method of advertising.

Locomotive Valve Gear.—The Baker-Pilliod locomotive valve gear, manufactured by the Pilliod Co., 30 Church street, New York, N. Y., is now known as the Baker Locomotive Valve Gear, and its functions are well described in a new catalog just issued by that firm. The important facts only are presented, and it is quite evident from a perusal of its pages that every effort has been made to state them as clearly and concisely as possible. The catalog is handsomely illustrated with halftones of several locomotives to which the gear has been applied, and it is thoroughly descriptive of the improvements which have been made in the motion since its advent into the railroad field. The latter portion of the catalog deals with breakdowns, and very valuable suggestions are offered as to the proper course to be pursued in the event of failure of any part of the gear. The catalog is in most attractive form and will well repay an attentive examination.

Electric Motors and Appliances.—The General Electric Company, of Schenectady, N. Y., has just issued several valuable bulletins descriptive of its varied output. The bulletin on voltage regulators has been revised and it illustrates and describes regulators for controlling the generator voltage and also those for regulating the feeder voltage. There are also reproductions of curves showing voltage with and without regulators installed. Bulletin 4784 is devoted to electric drive in pulp and paper mills. The advantages to be derived from the use of electric power in this industry are set forth, and a number of important installations are illustrated and described. Other bulletins which have been received from the same firm deal with direct connected generating sets; portable and stationary air compressor sets; electric drive in woodworking plants; small plane alternating current switchboard panels; belt driven alternators, and General Electric straight air brake equipments. Bulletin 4808 is of special interest as it deals comprehensively with the electrical equipment of the high speed electric railway connecting Washington, D. C., with Baltimore, Md. This publication is of general interest to railroad men.

NOTES

Ralston Steel Car Co.—This company, of Columbus, O., has increased its capital stock from $1,000,000 to $2,500,000.

Davenport Locomotive Works.—This company, of Davenport, Iowa, announces the opening of an office at 30 Church street, New York, N. Y., in charge of H. T. Armstrong.

Locomotive Superheater Co.—This company announces the election of George L. Bourne as its second Vice-President, with headquarters in the People's Gas Building, Chicago, Ill.

Niles-Bement Pond Co.—Effective January 1st, W. R. Lathrop assumed charge of the Birmingham sales office of the above company, and of the Pratt & Whitney Co., succeeding N. C. Walpole, resigned.

American Brake Shoe and Foundry Co.—This company, of Mahwah, N. J., has taken out a building permit to construct a one-story brick factory to cost $30,000 at 4500-4510 West Twenty-sixth street, Chicago.

Standard Coupler Co.—At the annual meeting of this company the present directors were re-elected. Although no official figures of the earnings are given out, it is said that they were the largest in the history of the company, and that plants are operating at practically full capacity.

Smith Locomotive Adjustable Hub Plate Co.—This company of Pittsburg, Kan., announces that its hub plate which has been adopted as standard by the Kansas City Southern Ry., is now being tried out by the Delaware and Hudson R. R., and by the St. Louis and San Francisco Ry.

Cement Age.—This well known magazine, devoted to the popular features of cement construction as well as the engineering manufacturing side of the industry, has consolidated with *Concrete Engineering*, published in Cleveland, O., under the title: *Cement Age, With Which Is Combined Concrete Engineering*. It is proposed to preserve the best features of each magazine, thus maintaining the prestige each has won.

Triumph Electric Co.—This company, of Cincinnati, O., have recently opened a sales office at 728 Poydras St., New Orleans. This is the sixteenth sales office now being maintained by this company, and is the third to be opened during the past year. The Triumph Co., in their new factory are doing a big business, and anticipate even greater returns during the coming year. A large stock of machines will be carried at the New Orleans office for immediate shipment.

Michel-Kurze Co.—The organization of this company, with offices in the Hudson Terminal Buildings, New York, has just been effected to do photo retouching and illustrating of machinery subjects. The business will be managed by A. Eugene Michel, Assoc. Mem. Am. Soc. M. E. and the staff of artists will be in charge of Wm. F. Kurze, who was Art Director of the Scientific Engraving Co. during the past four years, and is one of New York's best known artists in mechanical lines.

Detroit Seamless Tube Co.—The above company announces that Joint Offices have been opened in the McCormick Building, Chicago, by the Detroit Seamless Steel Tubes Co., Michigan Malleable Iron Co., and the Monarch Steel Castings Co., all of Detroit, for the sale in the West and Southwest, of Detroit Locomotive Flues, Detroit Journal Boxes and Monarch Couplers. Walter E. Marvel, formerly Manager of the St. Louis office of The Buda Company, has been appointed Western Sales Manager in charge of the Chicago Offices.

Bettendorf Axle Co.—This company announces that F. K. Shults, until recently connected with the American Steel Foundries as their representative in New York and Eastern territory, has taken a similar position with the Bettendorf Axle Company, of Bettendorf, Iowa, and of which company he has been made a vice-president. Mr. Shults has opened an office in Room No. 2040 Grand Central Terminal Building, New York City; the office at No. 30 Church Street, Room No. 1021 Cortlandt Building, will remain in charge of G. N. Caleb, vice-president, who has been with the Pettendorf Company the last eight or ten years.

The Dearborn Drug & Chemical Works.—This company which has distributed its Feed Water Treatment and Lubricants through an agency in the Phillippines for the past two years, has decided to open their own branch office and warehouse in Manila, and F. O. Smolt, who has been connected with mining propositions since his graduation in Chemistry from the University of Illinois in the Class of '91, has become connected with the Dearborn Company, and sailed on January 7th for Manila, to take charge of this work, under the supervision of E. C. Brown, Manager of the Foreign Department of the Dearborn Company. Mr. Brown has spent most of the past two years in Japan, China and the Philippines, investigating steam plant and railroad conditions in the interests of Dearborn Products, and is still there, having made selling connection at Tokyo Tientsin, Hongkong and Shanghai.

FOR YOUR CARD INDEX

Some of the more important articles in this issue arranged for clipping and insertion in a card index. Extra copies of this page will be furnished to subscribers only for eight cents in stamps.

Air Hose—Failures AMER. ENG., 1911, p. 45 (February).

Article by R. W. Burnett covering a very careful inquiry into the cause of failures determined by observations extending over a period of 9 months on a large trans-continental railroad.

Car—Twin Air Jack for Car Repairs

AMER. ENG., 1911, p. 54 (February).

Illustrated description of an extremely efficient air jack for lifting passenger car bodies and which employs a double-jack cylinder. Designed and built by New York, New Haven and Hartford R. R.

Locomotive, Smooth Rail Working on Heavy Gradients

AMER. ENG., 1911, p. 41 (February).

A discussion, largely theoretical, of certain problems in design to meet peculiar requirements which apparently have not as yet been satisfactorily solved. Based on a paper by F. W. Bach, before the Institution of Civil Engineers, England.

Locomotive, 2-8-8-2 Type AMER. ENG., 1911, p. 50 (February).

Total weight, 418,000 lbs.	Wheels, 57 in.
Weight on drivers, 360,000 lbs.	Total heating surface, 5,161.8 sq. ft.
Cylinders, 24½ and 39 in.	
Tractive effort, 83,300 lbs.	Steam pressure, 200 lbs.

Built by the American Locomotive Co. for pusher service on the 'Frisco lines. It is the first Mallet to be constructed with inside steam pipes to high pressure cylinders.

Locomotive, 4-4-2 Type AMER. ENG., 1911, p. 44 (February).

Total weight, 231,675 lbs.	Wheels, 73 in.
Weight on drivers, 112,125 lbs.	Total heating surface, 2,508 sq. ft.
Cylinders, 15 and 25 in.	
Tractive effort, 23,800 lbs.	Steam pressure, 220 lbs.

Built by Baldwin Locomotive Works for the Atchison, Topeka and Santa Fe Ry. It possesses the unique feature of outside dry and steam pipes and is the heaviest in total weight of any 4-4-2 type heretofore constructed.

Locomotive, 4-6-2 Type AMER. ENG., 1911, p. 56 (February).

Total weight, 250,500 lbs.	Wheels, 75 in.
Weight on drivers, 154,500 lbs.	Total heating surface, 3,328 sq. ft.
Cylinders, 25 in.	
Tractive effort, 37,700 lbs.	Steam pressure, 190 lbs.

Built by American Locomotive Co. for the Chicago and Northwestern R. R., where equipped with Schmidt superheater is giving excellent results in service.

Locomotive—Hollow Brick Arch

AMER. ENG., 1911, p. 58 (February).

Record of thorough test given the Wade-Nicholson hollow brick arch on a locomotive testing plant. These are apparently conclusive in establishing the increased economy of the hollow arch over that of the ordinary description.

Machine Tools—Cold Saw Cutting Off Machine

AMER. ENG., 1911, p. 74 (February).

New design of powerful metal saw built by the Newton Machine Tool Works, Inc.

Machine Tools—Heavy Duty Drill Press

AMER. ENG., 1911, p. 7 (February).

Very powerful tool built by Colburn Machine Tool Company, and especially designed for a wide range of heavy work.

Oil House—For the Santa Fe System

AMER. ENG., 1911, p. 52 (February).

Illustrated description of the equipment of the general oil distributing and storage plant at Topeka, Kans. The self-measuring pumps can transfer 300,000 gallons of oil in 10 hours. It is the largest and best equipped oil house in America.

Oxy-Acetylene Cutting Torch

AMER. ENG., 1911, p. 62 (February).

An illustrated article by J. F. Springer in which the application of the principle to metal cutting is fully described. A review of some noteworthy operations which have been performed through this process.

Shop Devices—Flue and Flue Sheet Tools

AMER. ENG., 1911, p. 65 (February).

Illustrated description of very ingenious flue beading tool which has been adopted on the Western Ry. of France. An exceedingly complicated device but possessing many points of merit.

Shop Devices—Cylinder Packing Ring Saw

AMER. ENG., 1911, p. 59 (February).

Illustrated description of very efficient double saw designed and built by Central of Georgia Ry. to dispense with hand work in fitting cylinder jacking rings.

Shop Devices—Tire Heater

AMER. ENG., 1911, p. 72 (February).

Illustrated description of a cheap and effective tool for heating tires when piled.

Locomotive Repair Shops at Brewster, Ohio

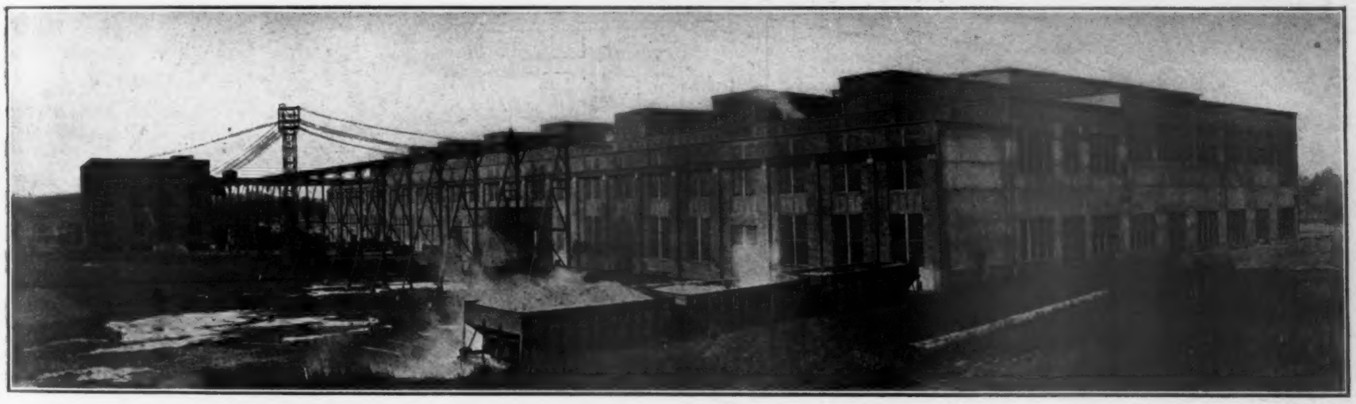
WHEELING & LAKE ERIE RAILROAD.

A COMPLETE LOCOMOTIVE REPAIR SHOP CONTAINING ALL EXCEPT THE POWERHOUSE AND STOREHOUSE WITHIN A SINGLE BUILDING. THE ERECTING SHOP IS OF THE TRANSVERSE TYPE AND THE TRANSFER TABLE IS REPLACED BY AN OVERHEAD CRANE OPERATED IN A BAY PARALLEL TO THE ERECTING SHOP AND BETWEEN IT AND THE MACHINE SHOP. PART OF THE BOILER SHOP OCCUPIES ONE END OF THIS TRANSFER BAY AND THE HANDLING OF HEAVY PARTS THROUGHOUT THE WHOLE SHOP IS WELL PROVIDED FOR.

Brewster, Ohio, has been founded by the Wheeling and Lake Erie Railroad at a point very near the geographical center of the system and there it has erected a complete new shop plant for making all repairs to its 225 locomotives. No other point on the road is provided with more than enough repair facilities to make the lightest kind of running repairs. Brewster is but 135 miles from the furthest terminal of the road, making it more economical to bring the power to this central point for all shop work than to maintain even moderate repair facilities at the various division points. Together with the shop there has also been erected a 26 stall roundhouse with a coal chute and other terminal facilities. A large freight yard has also been built at this point and freight car repairs will eventually be taken care of here.

While this company, together with the Wabash Pittsburg Terminal, now owns but 225 locomotives, the shop is designed to take care of all repairs on a total of 400 locomotives and therefore is not now being operated to its full capacity; nor has the full equipment of tools been provided for the capacity as designed.

It will be remembered that in the June, 1910, issue of this journal there appeared a general layout of this shop, together with a brief description of its general features. It was there noted that a unique idea formed the basis of the design of the erecting shop and the machine shop, viz., to build a transverse type of erecting shop, such as would ordinarily be constructed for use with a transfer table, and to then include the space devoted to the table within the shop building and to replace the table with an overhead crane, thus being able to make use of this space not only for transfer and admission to any track in the erecting shop, but also for the stripping, unwheeling, wheeling and finishing, as well as for storage of finished wheels, fitting of driving boxes, eccentrics, etc. This scheme effectually increases the capacity of the erecting shop by about 25 per cent. In practice it has been found convenient to use the pits located on every alternate track in the transfer bay, that may be opposite some engine in the erecting shop that is in for heavy boiler work, for light running repairs such as broken frames, tires turned, etc., and thus not take this class of work into the erecting shop proper at all.



GENERAL VIEW OF STOREHOUSE AND MAIN SHOP BUILDING AT BREWSTER—W. & L. E. R. R.

General Arrangement.

Inasmuch as all the shops are grouped within one large building the general layout requires but little comment. The shop plant itself consists of but three structures—shops, storehouse and powerhouse. The roundhouse is located near the powerhouse and the hot water boiler washing and filling system apparatus is located therein, but in other respects it is independent of the shop. The oilhouse is mostly for road engine use, but of course it is made large enough to serve the shop. The strictly locomotive terminal section of the plant will be considered independently at a later point.

The main shop building has been so placed as to permit easy extension at either end, in fact the end walls, while substantial, are considered temporary and the typography of the ground and location of the other buildings have been studied with this possibility in view. To the south of the shop building there is a clear space, about 100 ft. wide, covered by a 10 ton crane, with runways extending the full length of the building and a clear height of 36 ft. In this space are stored all heavy parts, such as wheel centers, frames, tires, axles, etc. The storehouse opposite the west end of the shop also adjoins this runway; in fact, its walls form the support for the girders, so that this crane becomes the principal and almost entire means of transfer of heavy raw material (except boiler plate, tubes and forgings) to the shop. Three tracks, serving the storehouse and scrap platform, extend under the crane, as do also the two entrance tracks to the shop, the connecting track between the shop and roundhouse and several connecting to the extensive system of narrow gauge track which covers the whole plant. In this manner this yard crane is given great flexibility for the transfer of material to and from cars, storehouse, roundhouse and storage space beneath it and any part of the shop. Entrance to the tender shop is from the west end and in the open space to the west of the shop are covered storage racks for tubes, bar iron, etc. The narrow gauge system furnishes the means of transfer from these points into

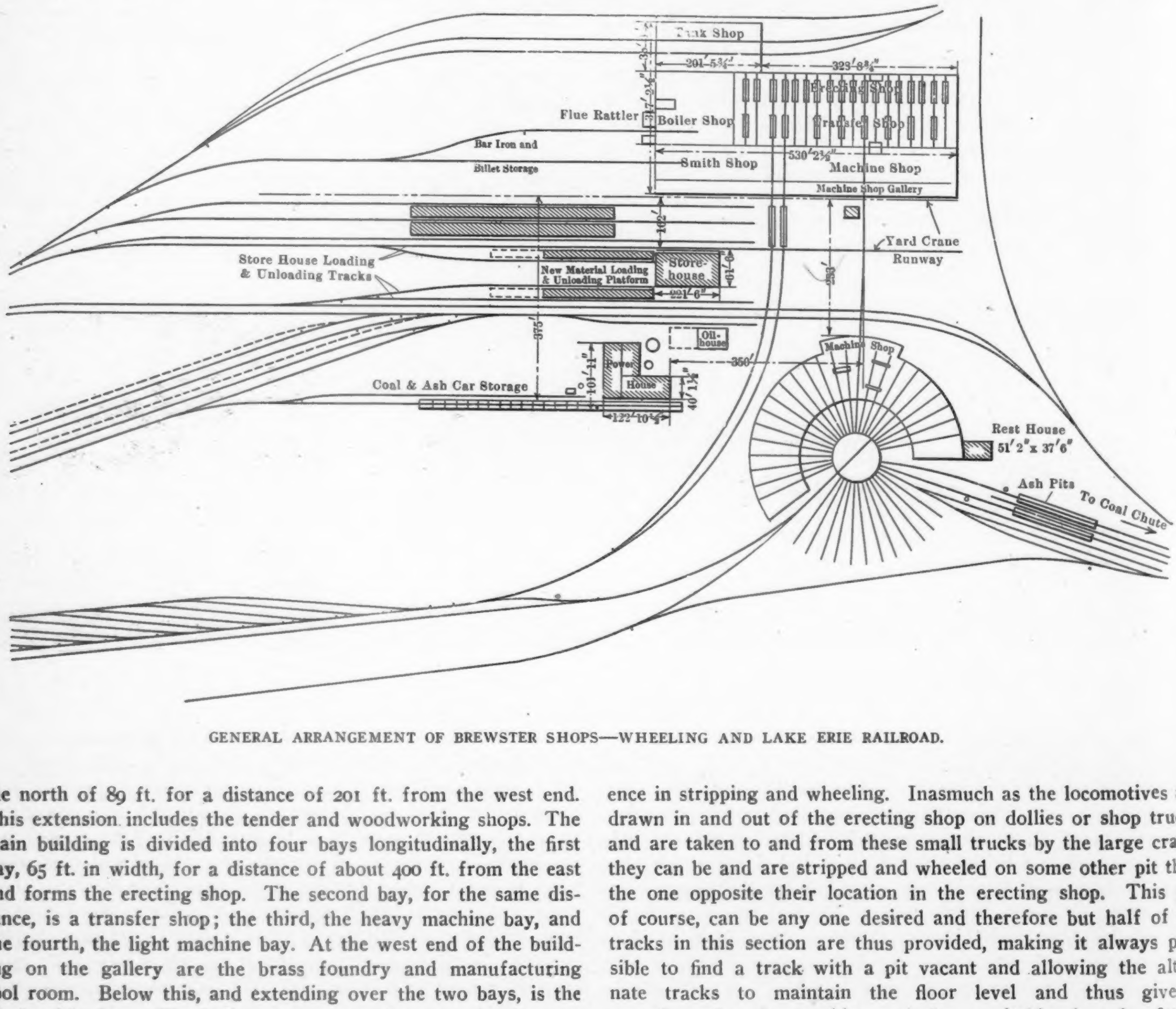
the shop. A full gauge track connection enters both the boiler and smith shop from the west, allowing cars to be loaded and unloaded by the shop cranes. The storehouse is equally convenient to both the shop and the roundhouse, while the oilhouse is located near the latter. The powerhouse location was determined by the desire to have the hot water washing and filling system in it, which necessitated locating it near the roundhouse. It, of course, also furnishes steam to the shops for power and heating and a concrete tunnel has been built for carrying these as well as the air and water pipes. The electric circuits from the powerhouse are carried overhead on steel poles.

MAIN SHOP BUILDING.

This building includes the following distinct shops: Machine, transfer, erecting, boiler, blacksmith, tender and a small brass foundry. It is 528 ft. long, 226 ft. wide, with an extension to the north of 89 ft. for a distance of 201 ft. from the west end. This extension includes the tender and woodworking shops. The main building is divided into four bays longitudinally, the first bay, 65 ft. in width, for a distance of about 400 ft. from the east end forms the erecting shop. The second bay, for the same distance, is a transfer shop; the third, the heavy machine bay, and the fourth, the light machine bay. At the west end of the building on the gallery are the brass foundry and manufacturing tool room. Below this, and extending over the two bays, is the blacksmith shop. The boiler shop covers the space in the next two bays at this end, and the flue rattler is in a small addition outside the end wall, the tubes, however, being placed in it from the inside of the building, as will be explained later. In the tender shop there is a 55 ft. bay for general tank and truck work and a 30 ft. bay with a gallery where the woodworking machinery has been installed. On this gallery pilots, headlights, etc., are repaired and painted.

Like most recent shop buildings, this is a steel frame structure with enclosing walls of vitrified paving brick pierced with large windows. On every third pit are large transverse monitors, 22 ft. 9¾ in. wide and 12 ft. 3 in. high, formed of steel framework, having a flat roof and sides composed entirely of windows. This arrangement, together with the many windows in the side walls shown in the elevation drawing, makes the natural lighting of the floor very evenly distributed and of unusual intensity. In fact the shop seems to be provided with as good natural lighting as could possibly be desired. The accompanying drawings show the design and arrangement of the structure sufficiently well to make extended comment unnecessary. Attention might, however, be drawn to the floor construction, which is used throughout the whole building except in the forging section. This consists of 3 in. pine planking laid on a foundation of broken stone 6 in. thick, covered with 1 in. of tarred sand. Over this is laid at right angles a wearing surface of the best 1⅛ in. matched maple flooring in 4 in. strips. The floor support near the erecting pits consists of ties 2 ft. 6 in. long and 9 in. thick bolted to the top of the concrete pits. The rails are secured to the same ties, which are laid close together.

It will be noticed that pits have been provided on every second track in the transfer shop. These are, of course, for convenience in stripping and wheeling. Inasmuch as the locomotives are drawn in and out of the erecting shop on dollies or shop trucks and are taken to and from these small trucks by the large crane, they can be and are stripped and wheeled on some other pit than the one opposite their location in the erecting shop. This pit, of course, can be any one desired and therefore but half of the tracks in this section are thus provided, making it always possible to find a track with a pit vacant and allowing the alternate tracks to maintain the floor level and thus give a smooth surface for trucking and also a suitable place for fitting driving boxes, eccentrics, etc.



GENERAL ARRANGEMENT OF BREWSTER SHOPS—WHEELING AND LAKE ERIE RAILROAD.

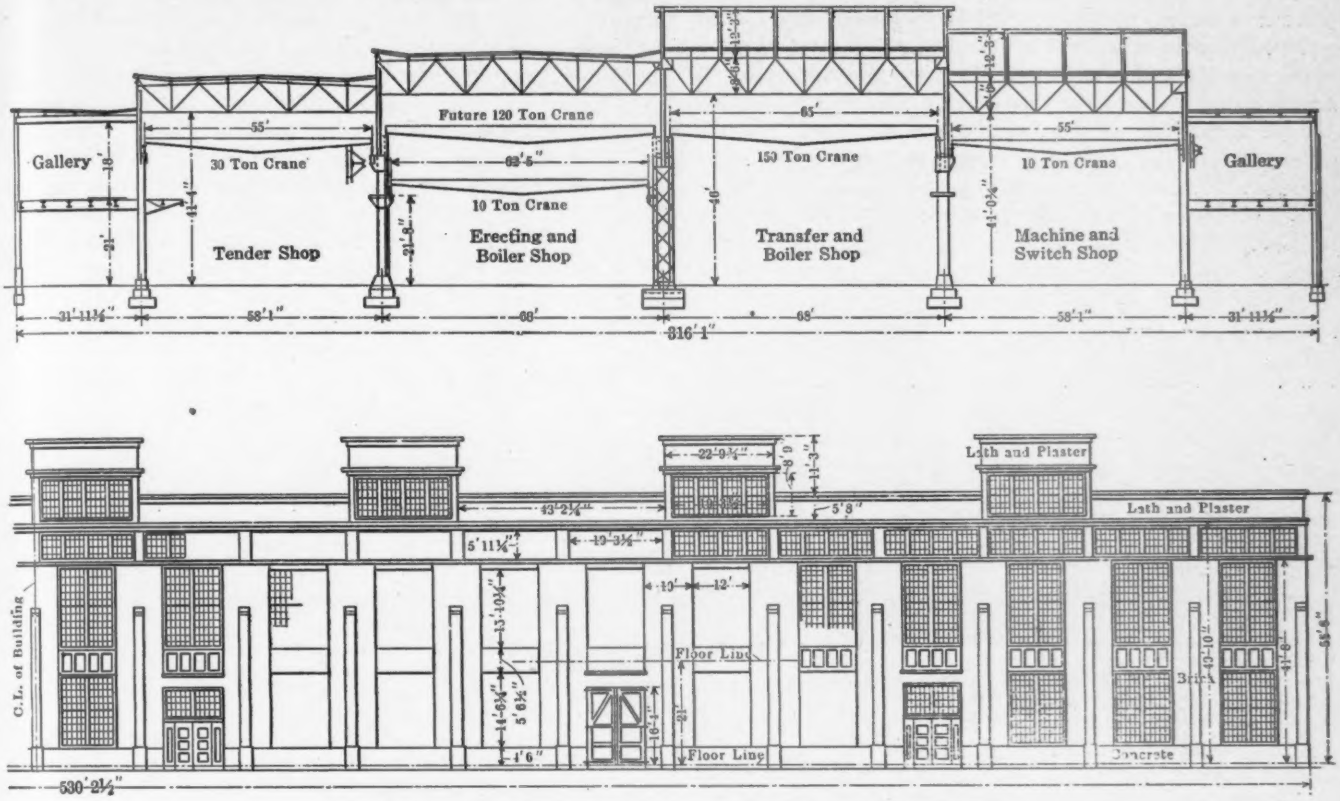
Overhead cranes serve the entire floor space of the shop with the exception of the galleries and the bays underneath them. In the erecting shop proper there is a 10 ton crane with a 65 ft. span, the runways of which continue over the boiler shop. In the transfer bay there is a 150 ton double trolley crane with a 65 ft. span running the full length of the building, and a 10 ton single trolley crane on the same runway. In the heavy machine bay there is a 10 ton crane with a 55 ft. span running the full length of the building and serving the heavy forges in the blacksmith shop. A 30 ton crane with a 55 ft. span covers one bay of the tender shop. In addition to this the boiler shop and blacksmith shop tools and forges are very completely provided with jib cranes. The location and arrangement of each

are clearly shown in the plan. The hydraulic riveter, of course, has its own 25 ton crane. All of these cranes are from the Shaw Electric Crane Co.

The complete and elaborate system of narrow gauge tracks inside the shop are clearly shown in the illustration of the tool arrangement. It will be seen that through the medium of turntables it is possible to get a connection from this track system to any part of the shop and beneath any desired crane. This system is equally elaborate outside of the building and connects with all the storage centers, storehouse, etc.

The heating of the building is through the medium of hot air, the fans, which are electrically driven, being placed in the transverse monitors in the roof and the ducts are carried along the roof trusses with outlets at the various desired points along the walls and columns. There are four of these fans, each driven by a 25 h.p. motor. The source of heat is the exhaust steam from the powerhouse.

The artificial lighting is all of enclosed arc lights suspended along the side walls and from the crane runways.

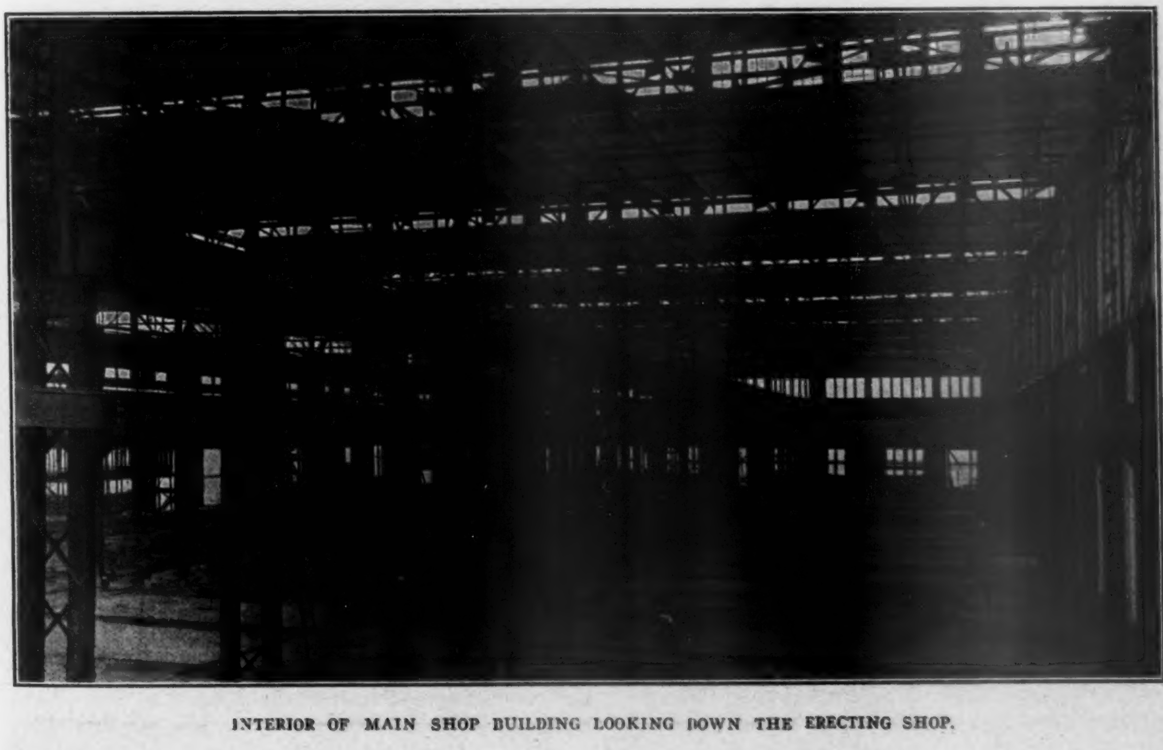


SECTION AND SIDE ELEVATION OF MAIN SHOP BUILDING AT BREWSTER.

Electric power circuits with numerous plug boxes for the portable machine, lights and electric winch are provided throughout the whole building.

OPERATION.

Locomotives which are to be shopped are brought up over a washout pit just outside of the shop building on the entering track from the south. The details of this pit are shown in one of the illustrations. It consists simply of a basin built of con-



INTERIOR OF MAIN SHOP BUILDING LOOKING DOWN THE ERECTING SHOP.

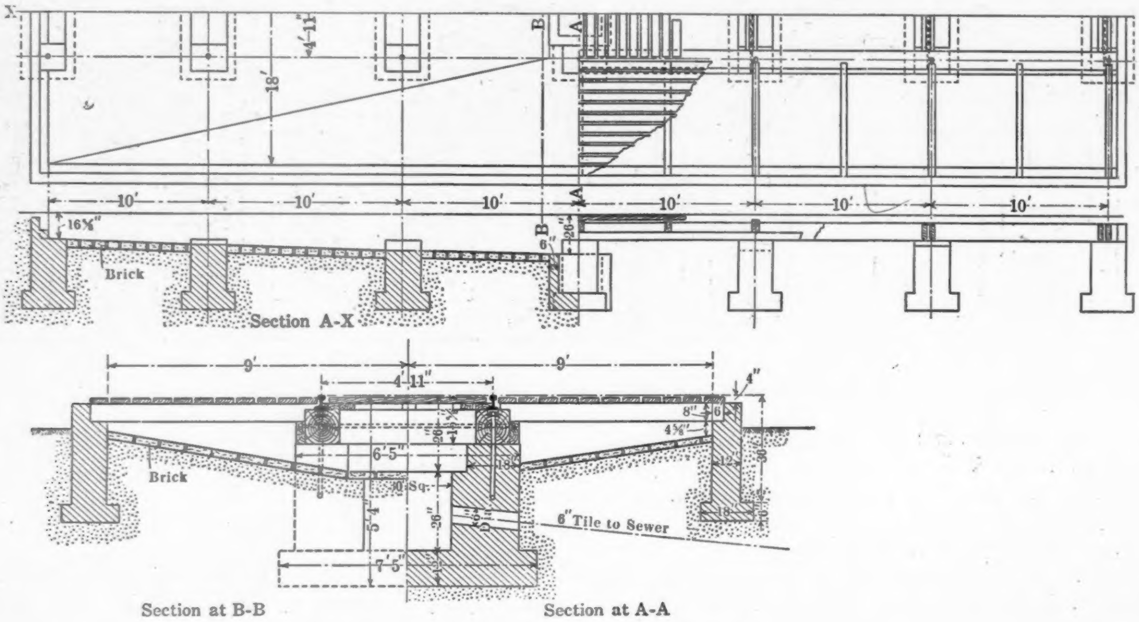
crete and lined with brick, 60 ft. in length and 18 ft. wide, which drains to a large sump in the center. This basin is 26 in. in depth at the center and about 16 in. at the ends and sides and the track is carried across it on heavy timbers supported on concrete piers. It is covered over the top with a grating consisting of 3 in. planks set about 1 in. apart. A hot water connection is located nearby and the whole running gear of the locomotive is washed down with hot water before it is taken into the shop and practically all of the heavy dirt and grease is removed before it enters the shop at all. It is then pushed on to the pit in the transfer shop, made ready and lifted from the wheels by the 150 ton crane and carried down this shop to the point opposite the pit in the erecting shop where it is to be located. It is then set down upon the shop trucks and the work of stripping is completed. Racks are provided alongside these pits for storage of piping and parts not needing repairs. After the stripping is finished it is drawn into the erecting shop by an electric winch, the arrangement of which is shown in one of the illustrations. The drum of this winch carries a steel cable, which is run around a block at the further end of the erecting shop,

intended to be the regular programme, but is often followed in the case of light repairs.

All wheels, rods, boxes, etc., left on the main incoming track after the locomotive is removed are disconnected and cleaned, the rods, boxes, springs, etc., being trucked to the hot water washing plant and cleaned before being distributed to the machine shop or racks. The wheels are rolled out on the same track the locomotive enters, underneath the 10 ton yard crane if it is desired to renew the tires. If, however, the tires are only to be turned they are, after cleaning, rolled under the 10 ton machine shop crane, which transfers them to wheel lathes. Tire heating is all performed in the small brick building, underneath the yard crane runway, which is provided with a jib crane and air hoist. Two large doors with roller steel shutters permit the wheels to be brought in or removed either to a track entering the machine and erecting shop or to the storage track.

In general the reversal of this scheme is followed for outgoing locomotives, a separate exit track alongside the incoming track being provided for this purpose.

Cabs, headlights and the pilots, etc., are lifted from the loco-



DETAILS OF WASHING PIT FOR LOCOMOTIVES.

there being a ring located in a recess in the floor at the end of each pit in both the erecting and transfer shop for securing the block. The cable is then drawn back to the coupler or other part of the locomotive and it is hauled into place in the erecting shop on the trucks. If the boiler is to be removed and taken to the boiler shop it is necessary to either bring the locomotive again into the transfer shop or to prepare the boiler for removal before the engine is taken to the erecting shop at all, as the large crane is used for this purpose and the boilers are repaired in the section of the boiler shop underneath its runway. Inasmuch as it is a comparatively simple matter to transfer a locomotive from the erecting shop to the transfer shop, it depends upon circumstances which method is followed. Flue work is performed in the section of the boiler shop near the west end underneath the 10 ton crane runway and this crane transfers the flues from the locomotive to the rattler and from the repaired flue racks back to the locomotive. Although the flue rattler is in a leanto outside of the building, there is a swinging steel door in the end wall and guides extending inside of the main shop, so that the flues can be deposited by the crane and slid into the rattler without any extra handling. They can also be removed in the same manner.

If necessary the whole locomotive, including its wheels, can be lifted by the 150 ton crane and carried over the tops of other locomotives in the transfer shop to the desired pit, and there repaired or removed from its wheels. This, however, is not

motive by the 10 ton crane in the erecting shop and set down upon push cars on the narrow gauge track, which transfers them to the crane or elevator in the tender shop.

MACHINE TOOL LAYOUT AND WORK DISTRIBUTION.

In studying the arrangement of tools as shown on the accompanying illustration it should be remembered that in a shop of this size devoted entirely to repair work there is not sufficient of any one class of work to keep particular machines or particular groups entirely supplied, and that while a particular machine is selected and located on a basis of the work which it will principally perform, it will also be called upon to do work of a character to which neither its design or location is especially well suited. Therefore it is not possible in a shop of this size to attain the high degree of perfection in the distribution of the work or of the grouping and classification of the machines. In this case it was also necessary to make use of considerable machinery that was already at hand in too good a condition to permit scrapping. The new tools purchased are of the highest character and show an intimate knowledge of both the work to be performed and the railroad machine tool industry.

Beginning at the east end of the heavy machine bay there is a 36 by 36 in. by 10 ft. Chandler planer used on rod brasses, guide yokes, guide yoke knees, eccentric rods, etc. This is driven by a 20 h.p. motor. The next machine is a No. 10 Newton vertical milling machine used for rod work. It is driven by a 10 h.p. motor. There is then a Newton two spindle rod borer, each

spindle being driven by a 7½ h.p. motor. This machine is used for main and side rod boring and miscellaneous heavy drilling.

Following this there is a group belted to a line shaft driven by a 35 h.p. motor, consisting of a 21 in. Betts slotter for connecting rod straps, cross heads, links, etc.; a 34 in. Fitchburg radial drill for drilling, tapping and reaming rod oil cups, large rod bolts, etc.; a swing grinder for rods and straps and a 79 in. Niles wheel lathe for tires and wheel centers. The next machine on this side of the shop is a 90 in. Niles wheel lathe, direct driven by a 30 h.p. motor. This adjoins the transverse full gauge track which runs from the erecting shop to the roundhouse. On the other side of the track is a 90 in. Niles wheel press, direct driven by a 7 h.p. motor and near by is a small babbitt furnace for counterbalance weights. Following this is a 42 in. by 11 ft. Schumacher and Boye triple geared lathe for axles, crank pins, etc. This is driven by a 15 h.p. motor. A high speed Niles radial drill driven by a 20 h.p. motor used on driving boxes, hub plates and miscellaneous heavy drilling is next, and is adjoined by a 66 in. Niles boring mill for wheel centers, tires, etc., and an 84 in. Betts boring mill for smoke box fronts, dome bases, smoke box rings, etc.; the latter machine is driven by a 10 h.p. motor and the former by a 35 h.p. motor.

On the opposite side of the heavy machine bay practically all of the machines are of the lighter variety, which do not require the service of an overhead crane. These machines are mostly driven from the line shafting with the groups in the light machine bay and form part of those groups. The first group at this end of the shop is belted from a line shaft supported in the center below the gallery and driven by a 50 h.p. motor. Beginning at the east end this consists of a 16 in. Niles slotter for driving box wedges, valve stem yokes, etc.; a No. 3 Bement horizontal boring mill for lift shafts and engine truck cradles; a 51 in. Bullard boring mill for boring and facing driving boxes, hub plates, etc.; a 36 in. by 8 ft. Pond lathe for reach rod jaws and washers; an 18 in. Cincinnati shaper for crown brasses, eccentric straps, etc.; a 56 by 56 in. by 6 ft. Gray planer for driving boxes, shoes and wedges, cellars, etc.; a 42 in. Lodge and Shipley lathe for miscellaneous work; a 72 in. Niles radial drill located underneath the crane runway for drilling and tapping cylinders and other miscellaneous heavy drilling. A Lucas power forcing press for pressing in brasses, etc.; a 24 in. by 10 ft. horizontal milling machine for link hangers, reverse levers, throttle levers, stub ends, etc.; a 42 in. Bullard boring mill for cylinder

TIRE HEATING BUILDING UNDER YARD CRANE.

heads and miscellaneous boring; a 60 in. Bickford radial drill for cylinder heads, steam chests, etc., and a 36 in. Bullard vertical turret lathe for piston packing, piston heads, cylinder heads, valve bushings, etc. In addition to these machines there is a 56 in. by 56 in. by 16 ft. Pond planer, direct driven by an 18 h.p. motor, for crosshead gibs, eccentric rods, main rod brasses, etc., and a Landis piston rod grinder, which is direct driven by a 15 h.p. motor.

In the next group, driven by a 40 h.p. motor, there is a 27 in. by 8 ft. Pond lathe; a small sensitive drill; a 24 in. by 8 ft. Pond lathe; a 32 in. by 9 ft. 8 in. Schumacher and Boye lathe; a 24 in. Enterprise shaper; two 24 in. by 8 ft. 6 in. Lodge and Shipley lathes; a 24 in. Fifefield lathe and a swinging grinder in addition to the tool grinders in the distributing tool room. A 36 in. by 36 in. by 12 ft. Fitchburg planer direct driven by a 10 h.p. motor forms part of this same group of tools. All of these

ELECTRIC WINCH FOR PULLING LOCOMOTIVES TO AND FROM THE ERECTING SHOP.

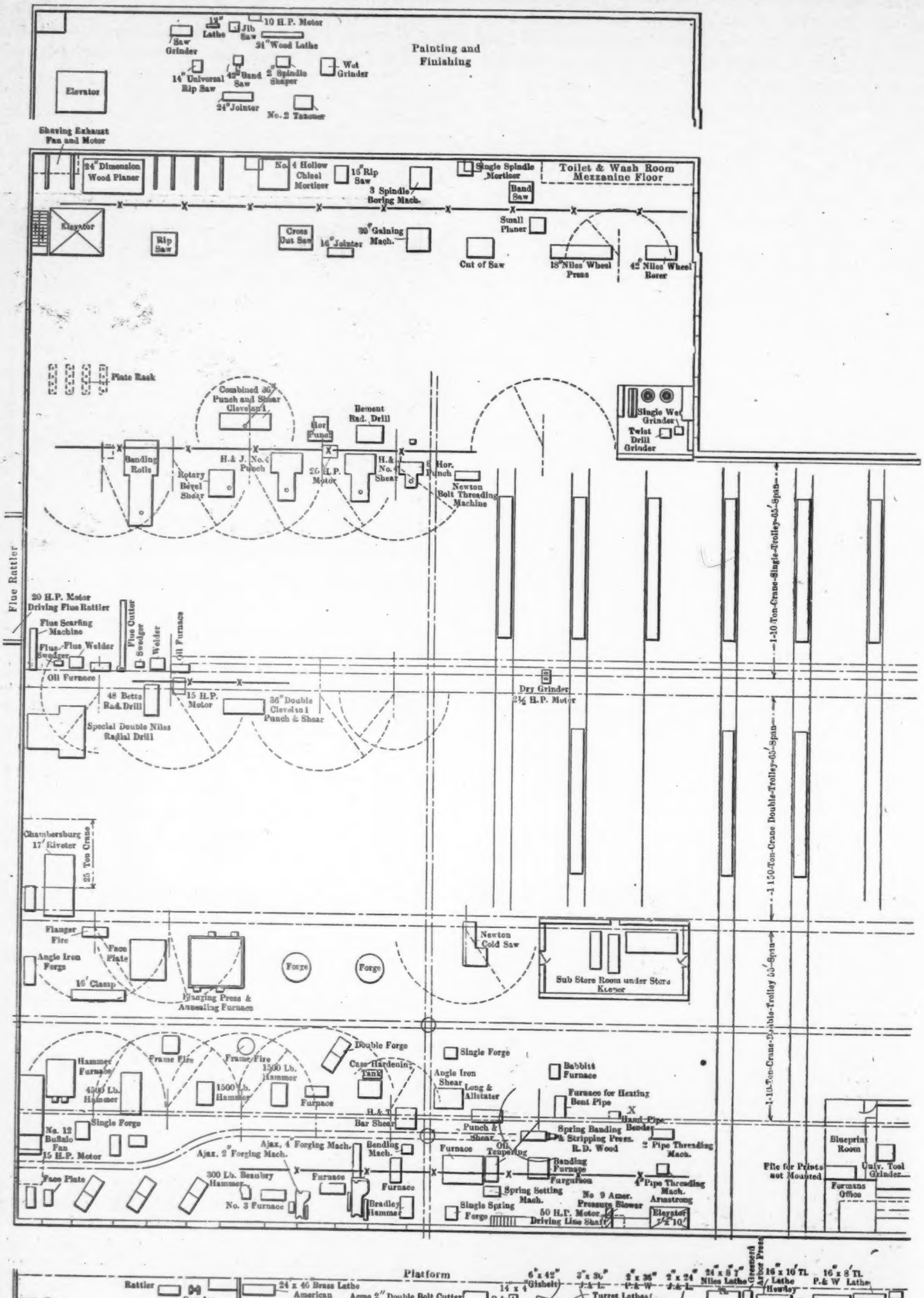
tools are used on miscellaneous valve gear and motion work.

At the east end of the gallery are the smaller tools for use on motion work, supplementing those located on the main floor under the gallery. A 7 by 10 ft. elevator gives connection between the two floors at this point. Practically all of these tools are devoted to work on valve gears, cross heads, throttle valves and pipes, steam pipes, etc. They consist of the following tools, all belted from a line shaft driven by a 50 h.p. motor:

32 in. by 8 ft. Schumacher and Boye Lathe.
42 in. by 9 ft. 8 in. Fitchburg Lathe.
Bement, Miles Radial Drill.
20 in. by 7 ft. Lathe.
36 in. by 36 in. by 12 ft. Pond Planer (15 h.p. Motor, Direct Drive).
Swinging Grinder.
15 in. Bement Slotter.
Hammett Link Grinder.
24 in. Pond Lathe.
60 in. Bickford Radial Drill.
24 in. Niles Slotter.
Diamond Guide Grinder.
21 in. by 5 ft. 6 in. Star Lathe.
Two 24 in. Pond Lathes.
18 in. Flather Lathe.
36 in. American Drill.
Swinging Grinder.

Adjoining this group on the gallery is a space for air brake repairs, which in turn is followed by the manufacturing tool room in which the tools are arranged to form one group driven by a 20 h.p. motor. Following this is the bolt room, where all knuckle pins, studs, staybolts, etc, are manufactured. The names and arrangements of the tools at this point is clearly shown in the illustration. At the far end of the gallery is a small brass foundry, separated by a partition. Just outside of this partition are several tools for brass work. The tools here are in two groups driven by 20 h.p. motors.

On the main floor under the gallery directly below the bolt room are the machines, furnaces, and benches for spring work. There is also space and several machines for the pipe work located nearby. The remainder of this end of the shop, covering



PLAN OF BUILDING AND LOCATION,

two bays, forms the blacksmith shop. In this there are two heavy forging machines, three large steam hammers, one of 4,500 lbs. capacity, oil furnaces for flanging, in addition to the usual forges, a Bradley power hammer, punches and shears, etc.

The next bay is given up to heavy boiler work, and consists principally of open floor space for handling complete boilers. At the end of the shop there is a hydraulic riveter with a 17 ft. gap and nearby a special double Niles radial drill, each drill being driven by a 20 h.p. motor. Alongside the row of columns are placed a 48 in. Betts radial drill and a 36 in. Cleveland punch and shear. A hydraulic mud ring riveter carried by a jib crane is also located in this section of the shop. In the next bay are the machines for forming and punching boiler plate and also for flue work. It will be noticed that these machines also adjoin the tank shop and can be used on tank plate, if desired. There are several other machines located on the other side of the columns intended especially for tank repairs.

In the woodworking shop are the usual collection of woodworking machine tools necessary for repairing tank frames, pilots and other locomotives and steam shovel parts. The names, sizes and arrangements of these machines is clearly shown in the illustration.

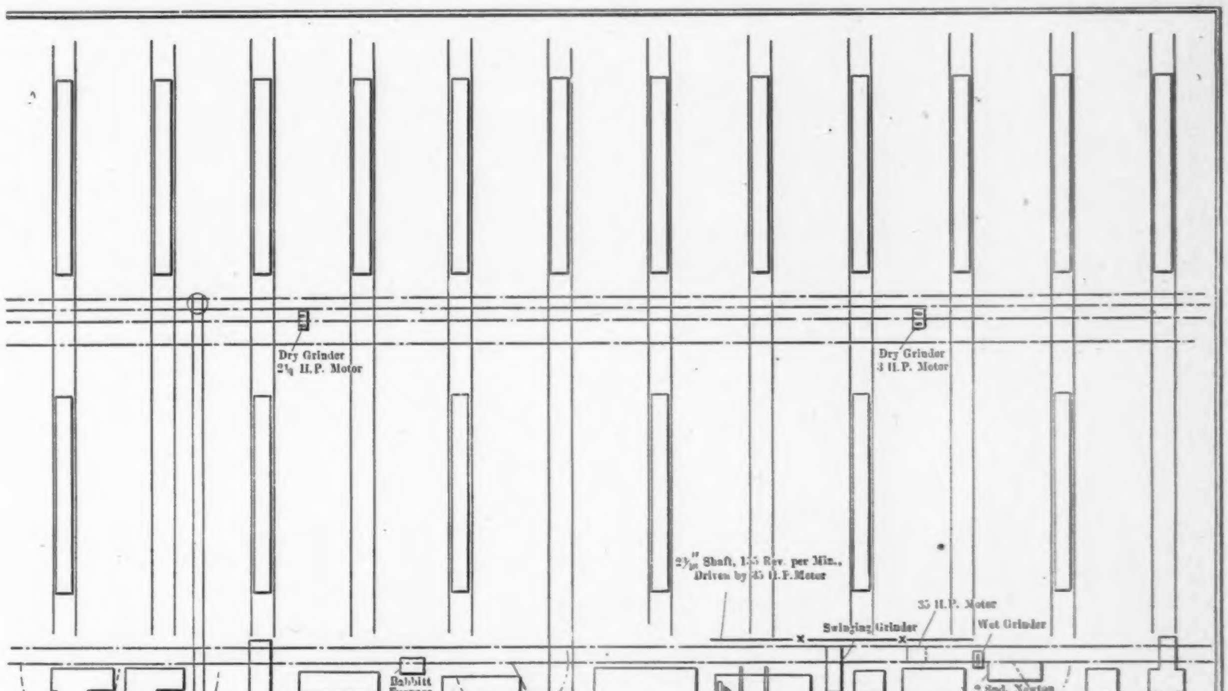
It will be noticed that there are no tools except one drill provided especially for cylinder work. All cylinders are purchased completely machined except drilling and finishing the smokebox fit.

STOREHOUSE.

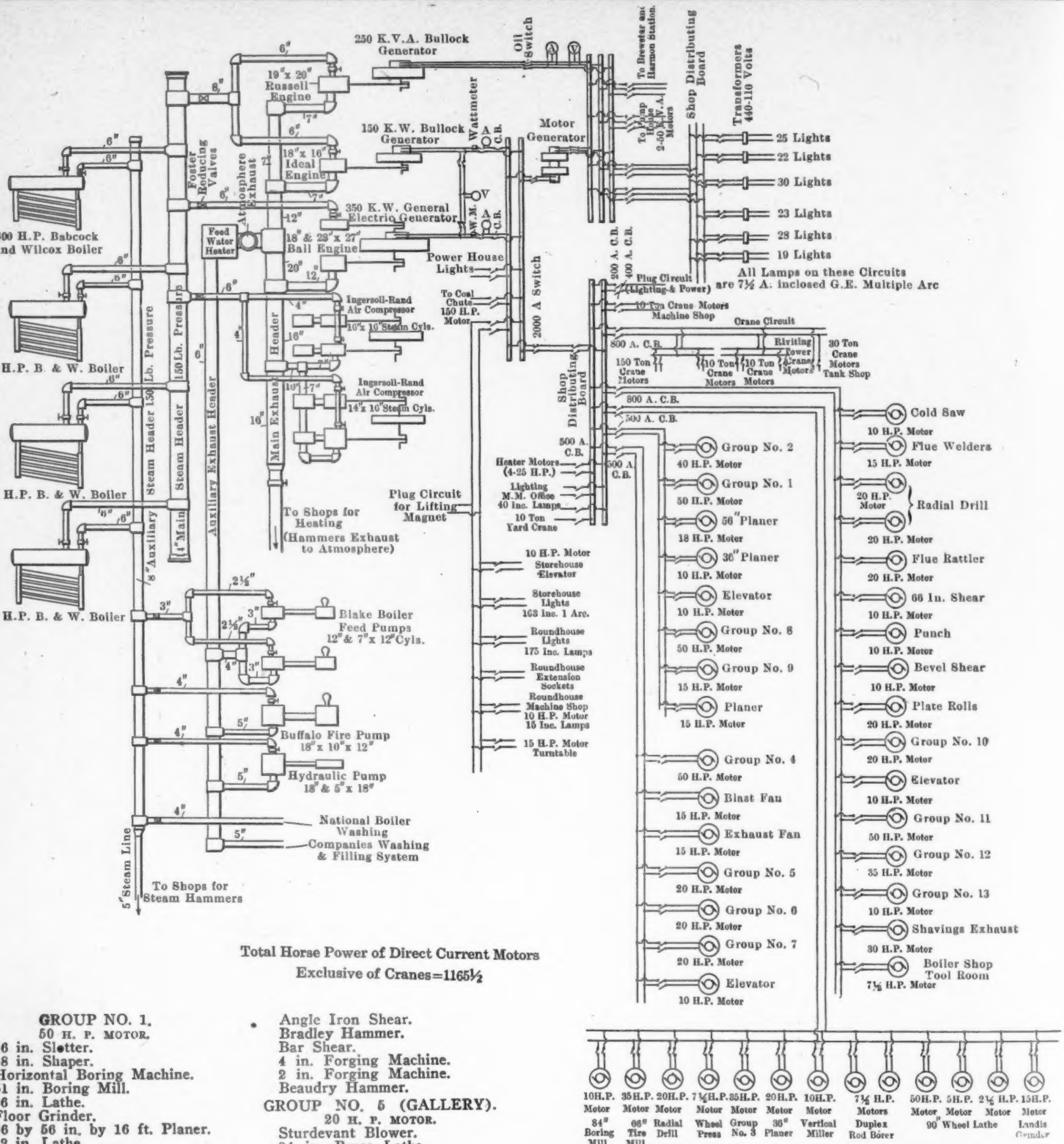
The storehouse building is a three story brick structure on a concrete foundation and presents no novelty of design or arrangement. The building itself is used only for the storage of small parts, and is provided with an elevator of suitable size and capacity. It is the central storehouse for the system and maintains a supply of the usual stores required for train and track service as well as for the shop. Castings, bar iron stock, tubes, pipes and other heavy parts belonging to the store stock are stored on platforms or in racks at some point convenient to the part of the shop in which they are to be used. A sub store is maintained in the main shop, where small supplies in constant use can be obtained immediately.

POWERHOUSE.

Reference to the diagram showing the power distribution will show the equipment located in the powerhouse, the exterior appearance of which is shown in one of the other illustrations. It will be seen that there is one 250 kw. alternating current generator direct connected to a 19 by 20 Russell engine and that this current is used at the shop altogether for lighting.



SIZE AND BUILDER OF MACHINE TOOLS AT BREWSTER.



GROUP NO. 1.
50 H. P. MOTOR.
16 in. Slotter.
18 in. Shaper.
Horizontal Boring Machine.
51 in. Boring Mill.
36 in. Lathe.
Floor Grinder.
56 by 56 in. by 16 ft. Planer.
42 in. Lathe.
72 in. Radial Drill.
Power Forcing Press.
42 in. Boring Mill.
60 in. Radial Drill.
36 in. Vertical Turret Lathe.

GROUP NO. 2.
40 H. P. MOTOR.
24 in. Lathe.
36 in. Lathe.
27 in. Lathe.
Sensitive Drill.
Floor Grinder.
24 in. Shaper.
24 in. Lathe.
24 in. Lathe.
24 in. Lathe.
Swing Grinder.
Tool Grinder.
Drill Grinder.
Wet Grinder.

GROUP NO. 3.
35 H. P. MOTOR.
21 in. Slotter.
34 in. Radial Drill.
Swinging Grinder.
79 in. Wheel Lathe.

GROUP NO. 4.
50 H. P. MOTOR.
4 in. Pipe Threading Machine.
2 in. Pipe Threading Machine.
Pressure Blower.
Spring Banding Press.
Punch and Shear.
Angle Iron Shear.
Bradley Hammer.
Bar Shear.
4 in. Forging Machine.
2 in. Forging Machine.
Beaudry Hammer.

GROUP NO. 5 (GALLERY).
20 H. P. MOTOR.
Sturdevant Blower.
24 in. Brass Lathe.
14 in. Fox Lathe.
18 in. Fox Lathe.
12 in. Drill.
Grinder.
1½ in. Bar Shear.
Lassiter Bolt Threader.
16 in. Lathe.

GROUP NO. 6.
20 H. P. MOTOR.
Sensitive Drill.
2 in. Bolt Cutter.
14 in. Horizontal Miller.
Lassiter Bolt Turning Machine.
Bolt Pointer.
6 in. Turret Lathe.
3 in. Turret Lathe.
2 in. Turret Lathes.
Bolt Altering Machine.
Double Bolt Cutter.
4 Spindle Nut Tapper.
Nut Facer.

GROUP NO. 7.
(Tool Room.)
20 H. P. MOTOR.
24 in. Lathe.
Arbor Press.
16 in. Lathe.
18 in. Lathe.
16 in. Lathe.
Universal Grinder.
32 in. Drill.
Sensitive Drill.
No. 4 Universal Miller.
No. 1½ Universal Miller.
Power Hack Saw.
Shaper.

GROUP NO. 8.
50 H. P. MOTOR.
Radial Drill.
32 in. Lathe.
20 in. Lathe.
42 in. Lathe.
Swinging Grinder.
36 by 36 in. by 12 ft. Planer.
24 in. Lathe.
Hammett Link Grinder.
60 in. Bickford Drill.
24 in. Lathe.
20 in. Lathe.
36 in. Lathe.
21 in. Lathe.
24 in. Shaper.
Flather Lathe.
50 in. Drill.
Swinging Grinder.
36 in. Radial Drill.

GROUP NO. 9.
15 H. P. MOTOR.
48 in. Radial Drill.
36 in. Punch and Shear.
2 Flue Swages.
2 Flue Welders.
Flue Cutters.
Flue Scarfing Machine.

GROUP NO. 10.
20 H. P. MOTOR.
36 in. Punch and Shear.
8 in. Horizontal Punch.
Radial Drill.
8 in. Horizontal Punch.
Bolt Threading Machine.

GROUP NO. 11.
50 H. P. MOTOR.
24 in. Wood Planer.
Rip Saw.
Hollow Chisel Mortiser.
Cross Cut Saw.
16 in. Rip Saw.
16 in. Jointer.

GROUP NO. 12.
35 H. P. MOTOR.
3 Spindle Boring Machine.
Single Spindle Mortiser.
Band Saw.
30 in. Gaining Machine.
Cut-off Saw.
Wood Planer.
18 in. Wheel Press.
42 in. Wheel Borer.

GROUP NO. 13.
10 H. P. MOTOR.
24 in. Jointer.
No. 2 Tenoner.
2 Spindle Shaper.
42 in. Band Saw.
Rip Saw.
Grinder.
24 in. Pattern Makers' Lathe.
12 in. Pattern Makers' Lathe.
Saw Grinder.
Jig Saw.

POWER DISTRIBUTION AT BREWSTER.

It is also used for driving the centrifugal pumps at the pumping house located some distance away. There are two direct current generators, one 150 kw. Bullock and one 350 kw. General Electric, the latter being driven by an 18 by 28 by 27 in. cross compound Ball engine and the former by an 18 by 16 in. Ideal engine. This current is employed for all machine tool motors, crane motors and incandescent lighting. Between the direct current and the alternating current bus bars has been connected a motor generator which will permit any of the generators to be operated alone and furnish current for all kinds of work. The method of connection and general arrangement of the circuits is shown on the power distribution diagram.

The hydraulic pump and accumulator are located in the power house and piped to the riveters in the boiler shop through the concrete tunnel connecting the two buildings.

GENERAL VIEW SHOWING POWERHOUSE, STOREHOUSE AND MAIN SHOP.

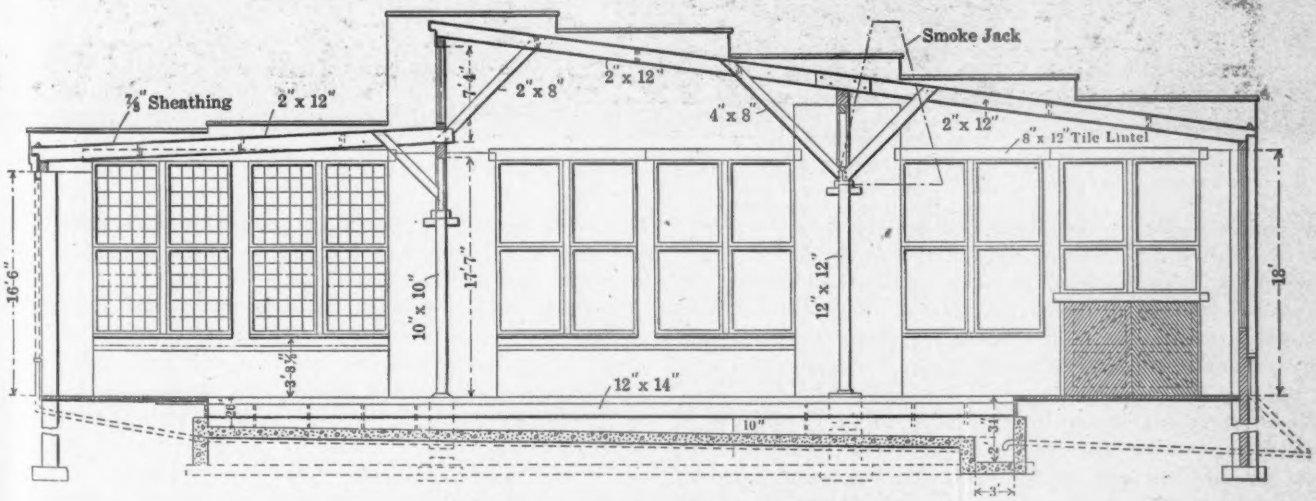
Draft is furnished by a 150 ft. chimney 9 ft. in diameter, made of radial brick. The coal for firing the four 400 h.p. Babcock and Wilcox boilers is brought in on a trestle alongside the power-house. Automatic Roney stokers have been installed with the boilers. Ashes are handled in the tunnel under the boilers and deposited into empty coal cars at the end of the trestle by means of a self-discharging air hoist arrangement, in which the buckets are drawn up over the top of the cars and discharged and returned automatically.

Water service is provided from three tanks, one of 100,000 gals. capacity, giving a head of 32 ft., and one of 265,000 gals. capacity, giving a head of 50 ft. at the powerhouse and one of 100,000 gals. capacity and a head of 50 ft. at the roundhouse. This service is for locomotive stand pipes and fire, as well as for shop use.

LOCOMOTIVE TERMINAL.

This section of the improvement was designed by the chief engineer of the railroad, H. T. Douglas, Jr., and consists of a 26 stall roundhouse with a 90 ft. turntable, a trestle type coaling station and a small roundhouse machine shop, together with the usual ash pits, inspection pits, etc.

The roundhouse is 90 ft. between walls and is constructed on the cross section shown in the engraving. The outer and end walls are composed principally of vitrified tile and the roof structure is of wood. The usual swinging doors with large lighting area are provided. Near the center of the house there is a driving wheel drop pit covering two tracks and two truck wheel pits covering the next two tracks. The machine shop is an extension on the outer wall near the drop pits and contains a small planer, forge, lathe and drill. It is simply intended for emergency repair work.



SECTION OF ROUNDHOUSE ERECTED AT BREWSTER.

Coaling Station.—This is a wooden structure, of the trestle type, on concrete foundations, the cars being drawn up by a cable from an electric winch. There are ten pockets, five on either side. The gates are of the under-cut type. On the same structure there are three bins for the storage of wet sand, the cars being unloaded into them from the trestle track. These bins discharge by gravity into the stove dryer and the sand is lifted into the dry sand bin by air in the usual manner.

Just east of the coaling station there are two large concrete inspection pits, each 130 ft. long, allowing the inspection of two locomotives on either track.

The ash pits, which are of the usual shovel type with the outer rail on the side wall, are located near the turntable as is customary and proper. The general plan of the whole shop shows the track arrangement and inter-relation of these various parts. A rest house and engine dispatcher's office forms an addition on the east end of the roundhouse structure.

The roundhouse is provided with the hot boiler washing and filling system, designed and erected by the National Boiler Washing Co.*

This shop was planned and erected under the direction of V. Z. Caracristi, J. E. Muhlfeld acting in a consulting capacity, the buildings being detailed and erected by Westinghouse, Church, Kerr & Co., 10 Bridge St., New York City.

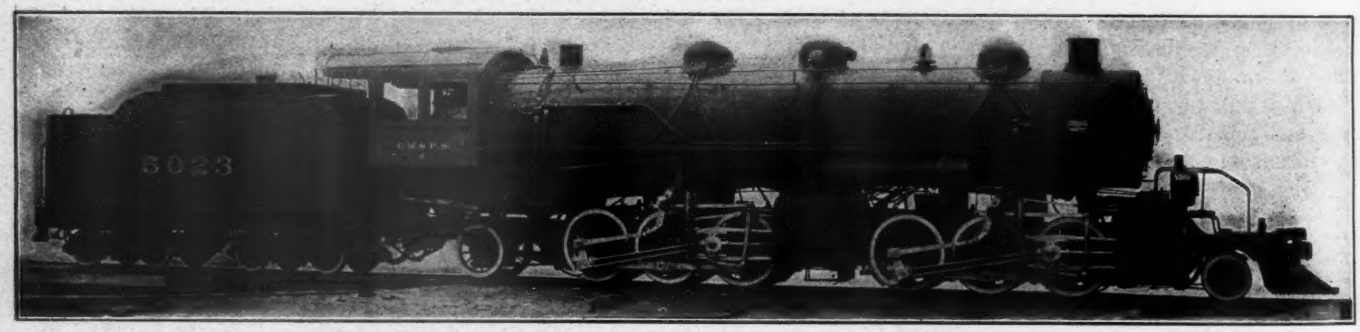
* For a full description of this system see AMERICAN ENGINEER AND RAILROAD JOURNAL, December, 1910, page 468.

Powerful Locomotives of the 2-6-6-2 Type

CHICAGO, MILWAUKEE & ST. PAUL RY.

THE AMERICAN LOCOMOTIVE COMPANY HAS RECENTLY DELIVERED 25 MALLET LOCOMOTIVES TO THE CHICAGO, MILWAUKEE & ST. PAUL RAILWAY, TO BE USED IN REGULAR ROAD SERVICE AND AS PUSHERS. THEY HAVE A TOTAL WEIGHT OF 390,000 LBS. AND A MAXIMUM TRACTIVE EFFORT OF 75,000 LBS.

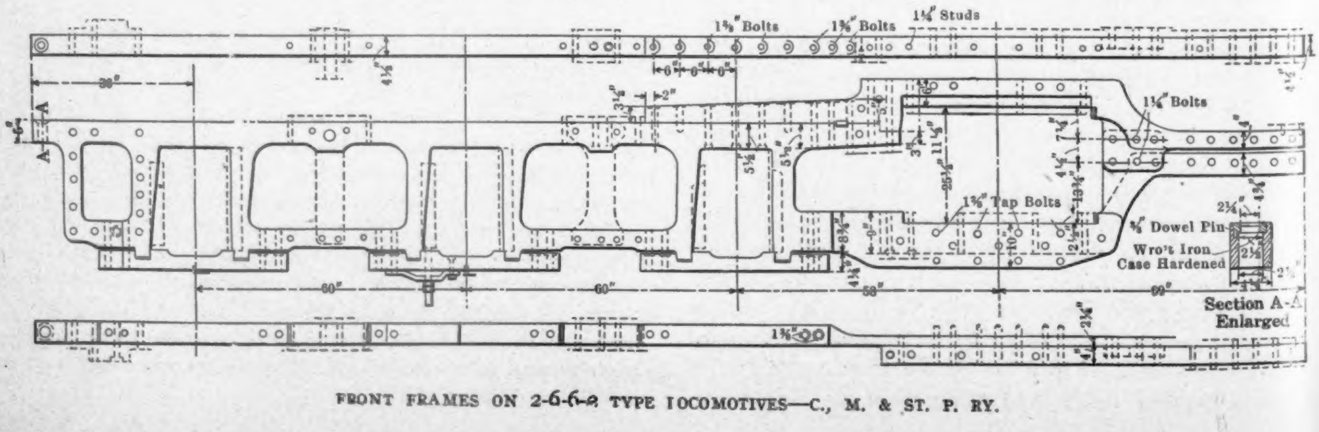
On page 471 of the December issue of this journal is given an illustrated description of a locomotive design from which 24 examples have been delivered to the Chesapeake & Ohio Railway by the American Locomotive Co. This order was placed after a careful test of a single engine of the same design, which had proven to be very satisfactory. The novelty of the design was confined principally to the very large boiler, which incorporated a 6½ ft. combustion chamber, and was illustrated on page 470 of that issue. Recently the same company has delivered 25 very similar engines to the Chicago, Milwaukee & St. Paul Ry., part of which will be used on the Chicago, Milwaukee & Puget Sound Lines, being intended for both regular road service and for pushers on some of the heaviest grades. Seventeen of these locomotives are equipped for burning coal, while the remaining eight will use oil as fuel, the latter being run on sections traversing the Idaho forest reserve.



LOCOMOTIVE WITH VERY LARGE BOILER FOR REGULAR ROAD SERVICE.

While the general design is very similar to the Chesapeake & Ohio engines, there has been some noticeable changes. The steam pressure has been reduced to 200 lbs. and larger cylinders and a shorter stroke have been specified. The cylinders of the Milwaukee engines are 23½ and 37 in. by 30 in. stroke as compared to 22 and 35 by a 32 in. stroke on the Chesapeake & Ohio. The driving wheels are 1 in. larger, or 57 in., and the combination gives a maximum rated tractive effort of 75,000 lbs. as compared with the 82,000 on the Chesapeake & Ohio design. The two boilers, however, are very much alike, both having 24 ft. tubes 2¼ in. in diameter, and a 78 in. combustion chamber, which brings the firebox back of the rear driving wheels and permits the securing of a good depth of throat. The number of tubes have been increased from 401 to 439, giving an increase of 536 sq. ft., the total being 6,554.6 sq. ft., as compared with 6,013 sq. ft. in the Chesapeake & Ohio engine.

The most novel feature of this locomotive is found in the use of separate exhaust pipes from each of the low pressure cylinders. It has been found that with the ordinary single exhaust pipe on Mallet locomotives, wherein the passages come together in the cylinder casting before entering the flexible pipe, there is a noticeable back pressure created by the exhaust from one cylinder backing up into the exhaust cavity of the other. Therefore in this case the exhaust is carried through entirely separate pass-



FRONT FRAMES ON 2-6-6-2 TYPE LOCOMOTIVES—C., M. & ST. P. RY.

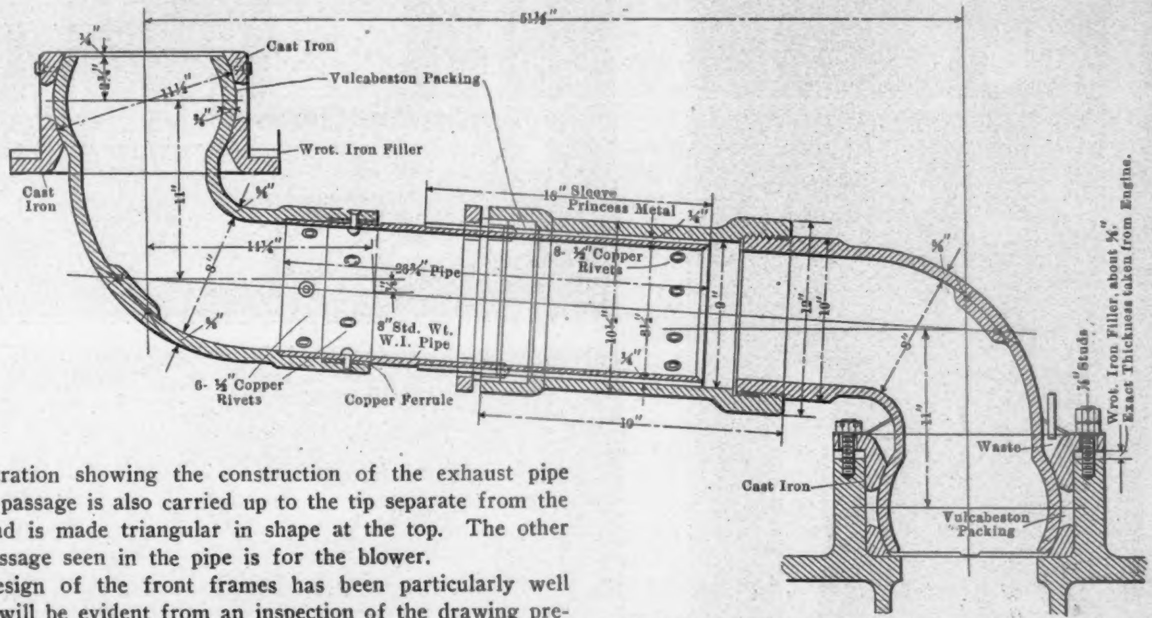
ages, and includes even separate tips. While this increases the number of flexible joints, since there are two flexible exhaust pipes from the low pressure cylinders, it is believed that the reduction in back pressure will offset this disadvantage. In the Mellin compound system, as used by these builders on Mallet locomotives, there is a separate exhaust lead from the intercepting valve chamber in the high pressure cylinder to the front end, so that when working simple the exhaust from the high pressure cylinder does not enter the receiver pipe. It will be noticed in the illustration showing the construction of the exhaust pipe that this passage is also carried up to the tip separate from the others and is made triangular in shape at the top. The other round passage seen in the pipe is for the blower.

The design of the front frames has been particularly well done, as will be evident from an inspection of the drawing presented herewith. A particularly strong connection between the front rails and the main frames, as well as the connection between the cylinders and frames, are clearly shown. In cases of this kind where very heavy low pressure cylinder castings depend entirely upon the frames, not only to hold them in place, but also to carry the whole weight of the castings, this feature is one which can well be given most careful attention, as has evidently been done in this case.

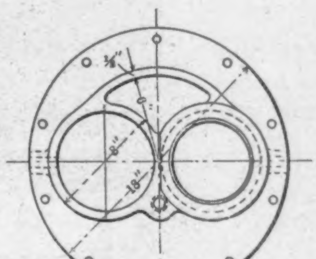
The trailing truck is of the De-Voy type, which has been adopted as standard on this system for all classes of locomotives using a trailer.

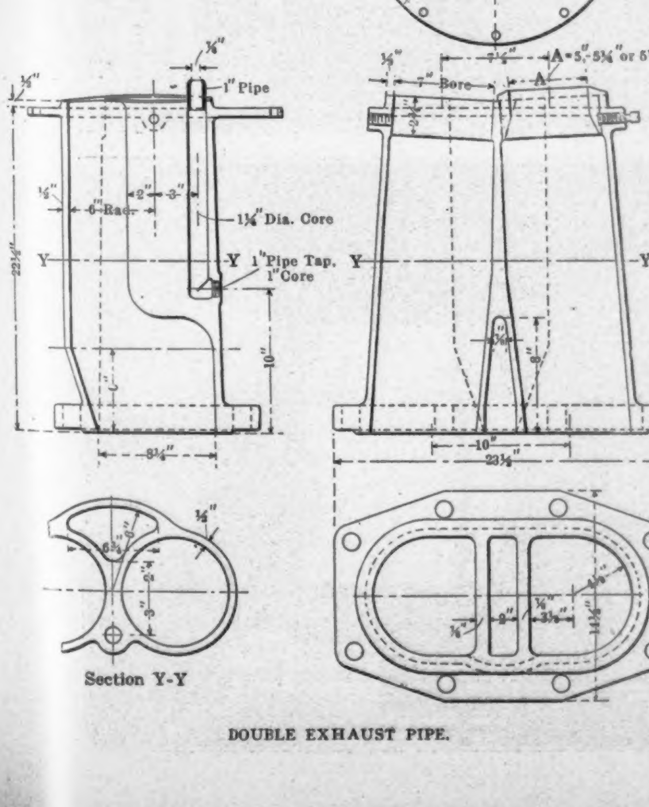
There is a slight difference in weight between the oil burner and the coal burning locomotives, due to the modifications required in the construction of the firebox, ash pan, etc., making the oil burners 2,500 lbs. lighter than those using coal, and giving them a total weight of 387,500 lbs.

The general dimensions, weights and ratios of the coal burning engines are given in the following table:



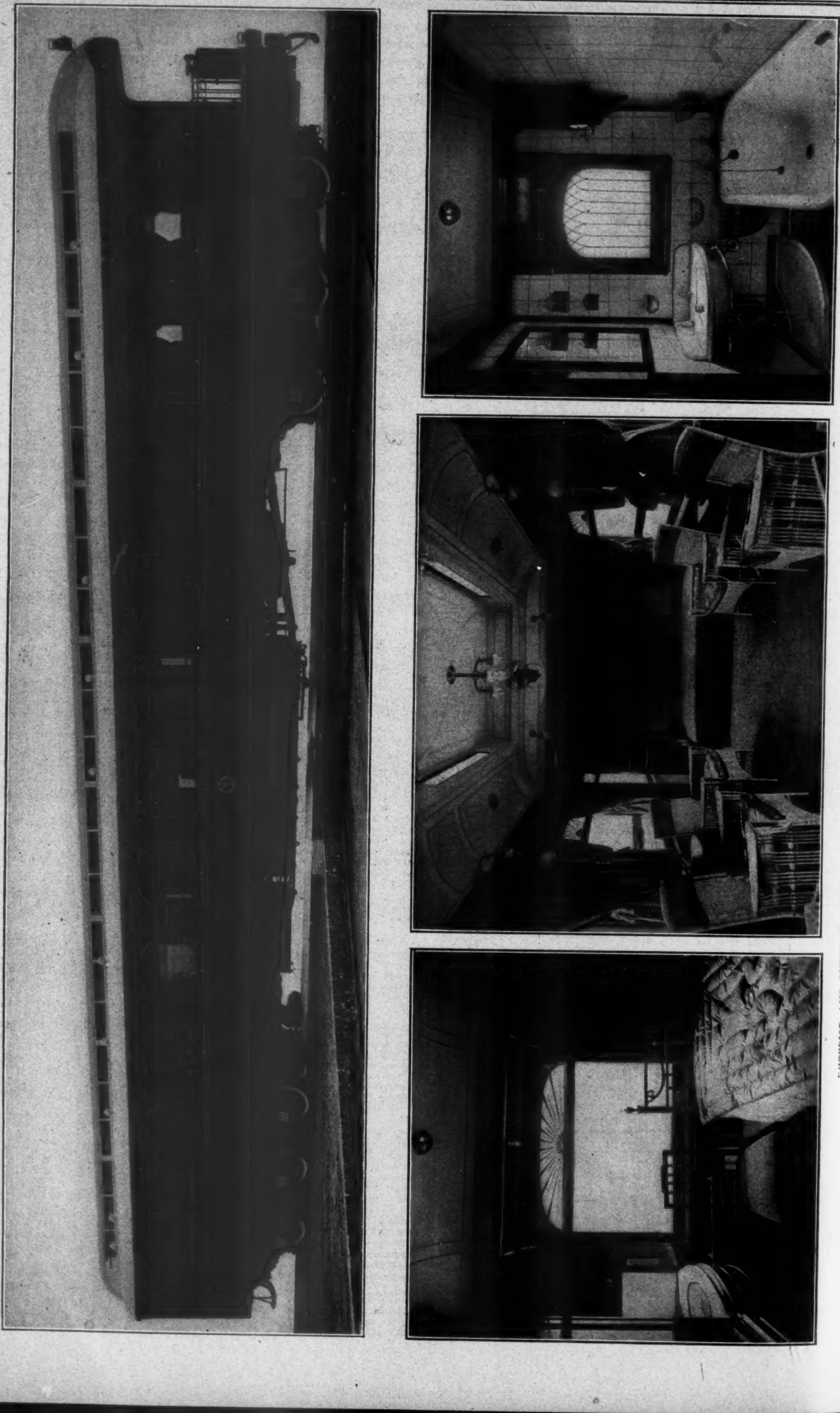
FLEXIBLE EXHAUST PIPE. THERE ARE TWO OF THESE ON EACH LOCOMOTIVE.





DOUBLE EXHAUST PIPE.

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. Coal
Maximum tractive effort	75,000 lbs.
Weight in working order	390,000 lbs.
Weight on drivers	323,500 lbs.
Weight of engine and tender in working order	555,700 lbs.
Wheel base, driving	30 ft. 6 in.
Wheel base, total	48 ft.
Wheel base, engine and tender	79 ft. 8¼ in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.30
Total weight ÷ tractive effort	5.20
Tractive effort × diam. drivers ÷ heating surface	653.00
Total heating surface ÷ grate area	90.50
Firebox heating surface ÷ total heating surface, per cent	5.69
Weight on drivers ÷ total heating surface	49.30
Total weight ÷ total heating surface	59.50
Volume equivalent simple cylinders, cu. ft.	22.80
Total heating surface ÷ vol. cylinders	288.00
Grate area ÷ vol. cylinders	3.18
CYLINDERS.	
Kind	Mellin Compound
Diameter	23½ & 37 in.
Stroke	30 in.
VALVES.	
Kind H. P.	Piston
Kind L. P.	Slide
Greatest travel	6 in.
Outside lap H. P.	1 in.
Outside lap L. P.	⅞ in.
Inside clearance	5/16 in.
Lead	3/16 in.
WHEELS.	
Driving, diameter over tires	57 in.
Driving, thickness of tires	3½ in.
Driving journals, diameter and length	10 x 13 in.
Engine truck wheels, diameter	33 in.
Engine truck, journals	6½ x 12 in.
Trailing truck wheels, diameter	43 in.
Trailing truck, journals	8½ x 14 in.
BOILER.	
Style	Conical
Working pressure	200 lbs.
Outside diameter of first ring	83¼ in.
Firebox, length and width	108 1/16 x 96¼ in.
Firebox plates, thickness	⅜ & ½ in.
Firebox, water space	F-5", S. & B-4½ in.
Tubes, number and outside diameter	439-2¼ in.
Tubes, material and thickness	Char-Iron, No. 11 B. W. G.
Tubes, length	24 ft.
Heating surface, tubes	6,182 sq. ft.
Heating surface, firebox	372.6 sq. ft.
Heating surface, total	6,554.6 sq. ft.
Grate area	72.3 sq. ft.
Smokestack, diameter	20 in.
Smokestack, height above rail	15 ft. 5⅜ in.
TENDER.	
Wheels, diameter	33 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	9,000 gals.
Coal capacity	14 tons.



EXTERIOR AND INTERIOR VIEWS OF PRIVATE CAR BUILT IN ENGLAND FOR SERVICE ON THE SOUTH MANCHURIA RAILWAY.

Luxurious Private Car for the Orient

THIS LATEST EXAMPLE OF BRITISH BUILT ROLLING STOCK IS FOR THE SOUTH MANCHURIA RAILWAY, AND IS OF PARTICULAR INTEREST IN VIEW OF THE MANY DISTINCTIVE AMERICAN FEATURES EMBODIED, AND THE SOLIDITY OF CONSTRUCTION, THE LATTER BEING SOMEWHAT UNUSUAL IN FOREIGN PRACTICE.

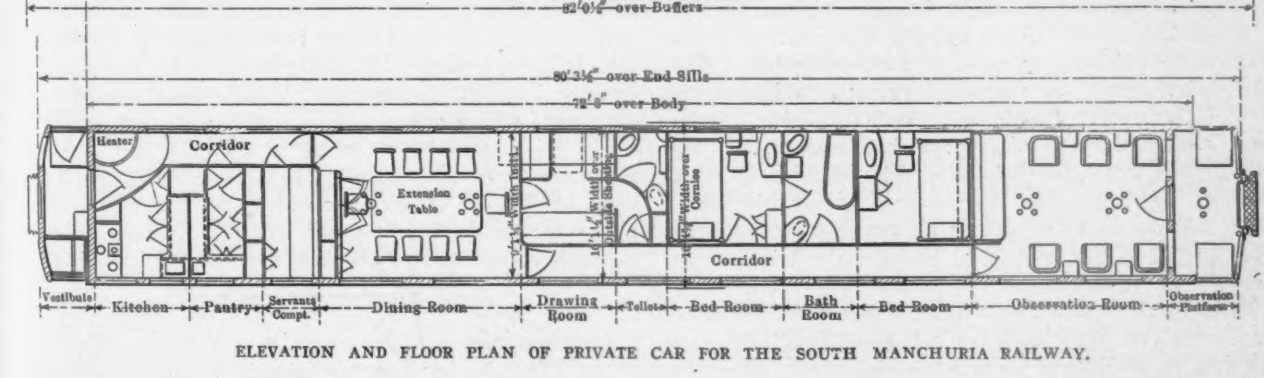
During the past few years the car builders of England have been working hard to secure a recognized position in the foreign field, and that their painstaking efforts have been rewarded with a measure of success is evinced through the many varied designs which of late have been evolved for the Russian and the various South American railroads. Recently the Leeds Forge Co., Limited, of Leeds, England, turned out a number of large and novel self-discharging hopper ballast cars for the Buenos Ayres Western Railway, and the order herein illustrated, which is of even greater interest, is that of an elaborate saloon car for the South Manchuria Railway, one which undoubtedly represents the most ambitious attempt to date on the part of English builders.

It will be noted that this car is representative of those privately owned on our American lines, and before proceeding with a description of its interesting details it may be well to mention that many departures from established English standards rendered its construction extremely difficult, and the fact that this was brought about in a way entirely satisfactory to the purchasers speaks well for the adaptability of the builders. Instead of the comparatively light design, which is conspicuous in foreign practice, they were compelled in this instance to contend with a car which in weight and general dimensions equals if not exceeds the dimensions established by practice in this country.

To this end it became necessary for the builders to make additions to their shop equipment, which heretofore had been entirely adequate to serve their needs, and to embody constructive ideas with which it may be assumed that they were not in entire sympathy. The drawings, of course, were furnished by the railroad company, and the car was built under a plan of purchaser's inspection, so exact in its requirements as to render any deviation from the latter's views a matter of sheer improbability.

The car which was constructed to the designs of M. Yoshino, chief mechanical engineer of the South Manchuria Railway, has a length of 80 ft. 3½ in. over the platforms; a width of 10 ft. over the side panels, and a height from the floor level to the underside of the roof of 9 ft. 8 in. The underframe is of steel throughout and of a most substantial design and arrangement. The body of the car is framed in teak strengthened by steel trusses and paneled on the outside with planished steel plates, the joints being covered by brass mouldings. The floors are double, with a space between packed with granulated cork. The roof is also double, with an air space between the inner and the outer roof, and is covered externally with prepared roofing canvas, the portion over the canopies being sheathed with copper. It will be noted that the trucks are of the 6-wheel type, with a wheel base of 10 ft. 6 in., and have triple coil anxiliary bearing springs, the main bearing springs being elliptical. The wheels have disc wheel centers with steel tires and axles, and the journal boxes are adapted for oil lubrication. The couplings and draft gear are the Buhoup three stem automatic type, with cast steel heads and knuckles and helical springs, and fitted with a special coupling device operated from the platform or vestibule. The car has the Westinghouse automatic air brake acting on all the wheels, and also an independent hand brake, this latter being worked from either platform by a patent ratchet brake handle.

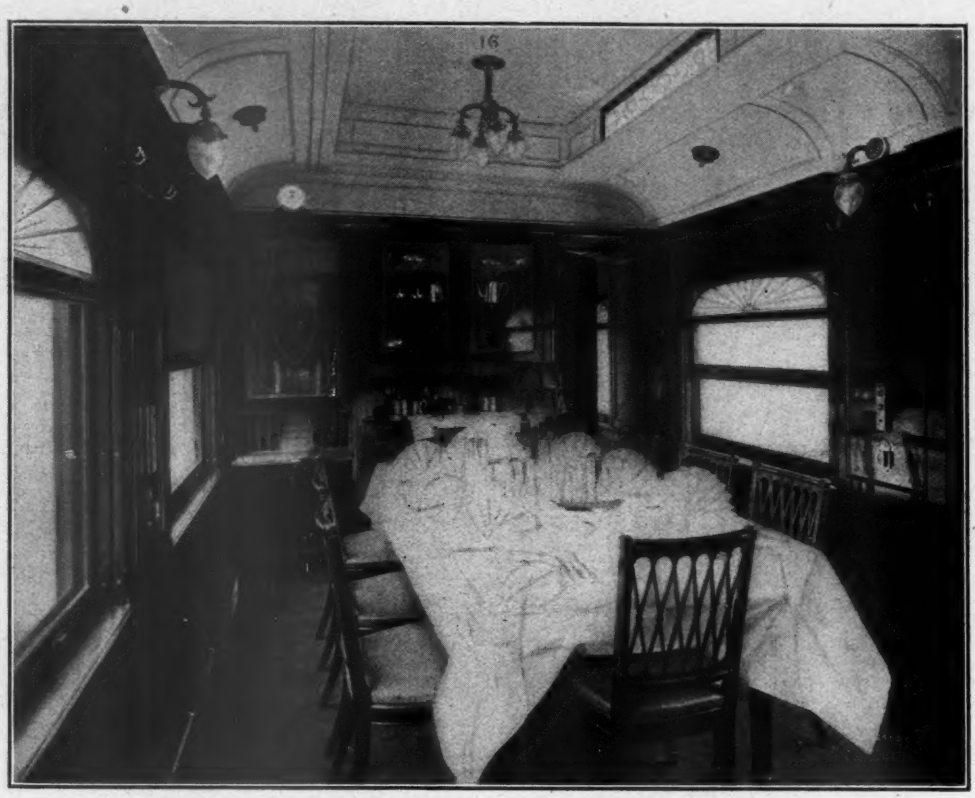
The general plan of the car is as follows: At one end is an open platform, having a brass hand railing with gates of ornamental design, and which is furnished with curtains by which it can be closed in when required. The floor is covered with india rubber tiling and has a trap-door at each side which closes over the platform steps. Opening from this platform there is an observation room, furnished with lounge chairs and a large couch upholstered in morocco. The back of this couch is arranged to turn up to form a berth when needed, and there are also hinged tables placed in convenient positions. A corridor leads from this room past the various staterooms to the dining room. There are two bedrooms, each furnished with brass bedsteads, wardrobe, washstand, dressing table, etc., with a communicating bathroom and lavatory connected by doors with the two bedrooms. The drawing room is entered from the corridor and has two seats constructed to pull out at night to form a berth and with a couch placed against the partition



ELEVATION AND FLOOR PLAN OF PRIVATE CAR FOR THE SOUTH MANCHURIA RAILWAY.

of the corridor. There is also a handsomely paneled Pullman berth, which folds up into the roof. A toilet room opens out of this room.

The adjoining dining-room is furnished with an extended dining room table, giving accommodation for ten diners; a sideboard with cupboards above and below, a folding writing table with an upper bookcase, also a removable table in one corner. From the dining room there is a second corridor which communicates with the servants' apartments. These latter consist of a small compartment with a long seat, the back lifting up to form a second berth; a pantry, with a tiled floor; and a kitchen, with range and all conveniences which occupies the remaining space in the body of the car.



ARRANGEMENT OF DINING SALOON.

Opening from the corridor at this end is a closed vestibule, with a large refrigerator on one side, and this end of the car is fitted with a Pullman collapsible gangway. All the staterooms are handsomely paneled in five-ply figured Cuban mahogany, with ebony and satinwood stringing and beading, and the floors are covered with heavy Wilton carpets, laid on linoleum. The furniture is of mahogany throughout, and the upholstery of the seats green morocco. The windows of these compartments are double, the lower being glazed with plain plate glass and the upper windows with cloisonne art glass of handsome design on the inside, and leaded cathedral glass on the outside. The lower windows are fitted with patent balances, lifts and draft excluders, also with spring blinds. The clerestory windows are glazed with cloisonne art glass and have wire gauze screens on the outside. The windows of the observation room are furnished with curtains of rich material. The ceilings are of "Tynecastle" or decorative design, richly moulded, and finished in light cream. The car is lighted throughout by Stone's system of electric lighting, with electroliers of handsome and artistic design in the observation, dining, drawing, and bedrooms, and with single lamps over the platform and in the corridors. Emergency candle lamps are provided in various parts of the car, and electric bells are connected to the servants' compartment.

Electric fans are fitted in all the rooms, and there is an exhaust fan in the kitchen. The dynamos and storage batteries are suspended from the underframe. Torpedo ventilators are fixed in suitable positions in the roof. The corridors are paneled in wainscot oak throughout, the floors being covered with linoleum and carpeted. Special attention has been given to the matter of heating, and this is taken care of by a main steam pipe which connects with the locomotive, having Gould's universal straight port coupler and valve, tee traps to each drain end of the return pipes, and with a temperature regulator to the inlet pipes.

A second system of heating is also provided by means of a vertical boiler, fixed at one end of the car, which can be used if required when the car is standing. The heating pipes are carried through the various rooms and corridors, and are covered with brass ornamental grids; radiators are also placed in the main compartments. Provision is made for the supply of hot water to the bedrooms, bathroom and toilet room, from a tank fitted in the roof of the kitchen, heated from a boiler in the range, and kept supplied with water automatically by pressure from the air brake system. The main water supply is by two tanks suspended from the underframe. All the steam and water pipes are lagged with asbestos.

The painting of the car is in the best style of English coach work, the body finished deep olive green, lined in gold, trucks and underframe a darker color with bronze finish, and the whole highly varnished. It is a product of the Metropolitan Amalgamated Railway Carriage and Wagon Co., of Birmingham.

TIME REQUIRED FOR CHANGE OF MOTIVE POWER.—Records kept by the Pennsylvania Railroad Company of the time consumed in changing from electric to steam motive power, and vice versa, at Manhattan transfer station, near Harrison, New Jersey, show that ninety-eight per cent. of the trains now go through the transfer in the time allotted for the change of power. From 106 to 109 trains pass through the transfer on week-days. No more rapid a change from steam to electric engines is made elsewhere on a large volume of traffic. The time allowed for uncoupling, switching and coupling is four minutes. Owing to the difficulty of detaching the steam hose from the engine during cold weather, it has not been thought advisable to make a shorter time allowance during the winter months, but with the warm weather it may be cut down. Thus far the record for the change is one minute and thirty seconds.

Alloy Steels for Railroad Use

ABSTRACT FROM A MOST INTERESTING AND VALUABLE PAPER ON THIS IMPORTANT SUBJECT READ AT THE RECENT JOINT MEETING OF THE ENGINEERING CLUB AND THE ALTOONA RAILROAD CLUB.

HENRY SOUTHERS.

To talk about alloy steels is to talk about heat treatment of steel. The subjects are inseparable if utility be a consideration. In the so-called "natural" and annealed state, alloys of iron used for structural purposes requiring strength and toughness have but little or no intrinsic value over and above plain carbon steels in a similar condition. The "natural" state, so-called, may cover many states, good, bad and indifferent as to quality. It might be better called an accidental state. If the physical and heat treatment preceding has been proper, then the natural state is not bad. But unless this treatment be under well regulated control, there is no certainty of result. Take, for example, plate rolling. Most of the plates are tough and will withstand shock and bending and exhibit all the desirable qualities. But once in a while a plate is rolled that breaks in subsequent handling without undue punishment under normal treatment. Both the good and the bad plates are in a natural condition, but in the case of the bad plate there has been some commission or omission, or an unfortunate sequence in the heating, rolling and cooling treatments.

An annealed steel is by far safer, although not always as strong perhaps. By "strong" I refer to elastic limit per square inch. It is safer, because if the annealing operation be properly conducted, all previous conditions of physical treatment have been obliterated, and a fixed predetermined condition established. A condition under control has been realized, and surely that is better than one not under control. The performance of a given quality of annealed steel may be predicted—its elastic limit, reduction of area, elongation and tensile strength. The arrangement and size of crystals are known, too, and this is the most important, as all physical results depend upon the condition of the crystals. A coarse-grained steel of any given quality will not break with the same good reduction of area as a piece in which the crystals are fine. Neither will the elongation be as good, but the reduction of area is most affected by crystal size. In other words, the reduction of area in a tensile test is the best single measure of grain size. The so-called "natural" condition of a bar of steel that is to be heat treated is of the utmost importance. If by chance the bar has been so forged or rolled and finished at a high temperature (say 1800 deg. F.) the grain of the steel will be coarse and the crystals shiney and "firey," so-called. This being the case, a simple toughening heat treatment carried on at proper temperatures (say 1500 deg. F.) will not refine this grain as it should. A double treatment becomes necessary, the first quench being at a high temperature (say 1725 deg. to 1750 deg. F.), followed by a lower quench at 1500 deg. F. or thereabouts; or a full anneal followed by a quench will answer the same purpose.

Briefly, steel is put into a bad condition by high temperatures and will not refine properly under a single treatment at low temperatures. All this applies to high carbon steels, to low carbon steels and to alloy steels. It has been learned by bitter experience that tool steel and spring steel (which is one grade of tool steel) should be annealed before hardening for use in tools or springs. If not, the chances are that the resulting grain in the finished tools or springs will be coarse and the tool or spring more brittle than desired. The experienced European makers who have obtained a strong foothold in this country have done so by delivering to customers steel that is not only uniform in composition but in physical condition as well. The statement often made by users of some brands of European tool steel is to the effect that "The steel is always the same, year after year." So is much American tool steel as to composition, but not as to physical composition. Tools machined directly from the bar are influenced most by these physical differences.

Three terms in common use are "anneal," "heat treat," and "draw." The full meaning of these terms should be understood. An "anneal" in the full sense of the word is to heat steel to a temperature above its critical point and then cool slowly. No holding for any length of time is necessary in carbon steels. But it must be certain that the temperature has actually been reached by the entire mass of the steel. In alloy steels some holding (not over an hour) is wise, to allow for a certain amount of "lag" which exists in combinations of carbon and the usual alloying elements—nickel, chromium, tungsten. The term "heat treatment," as commonly used, indicates a sequence of heating, quenching and drawing operations, with many variations to meet existing differences in critical temperatures of the steels treated and of results desired. "Drawing" is the term applied to the operation of heating to a temperature lower than the critical point, followed by slow cooling. These drawing temperatures range from those necessary to relieve internal strains (350-400 deg. F.) to those which materially soften the steel; that is, as high as 1,400 deg. F. Drawing is often the final operation in a heat treatment.

It is often apparent that there is a general distrust of heat treatment among those first coming in contact with the commercial application of the ideas underlying the system. A feeling exists that although the scheme may work for improvement in a laboratory, it may prove to be unreliable through lack of control in actual manufacturing operations. This is a mistaken idea. Experience indicates that heat treated steel is most uniform and that necessary refinements to produce such uniformity are practical in any fairly well regulated shop. Laboratory experiments seek to produce exact result from most manipulation with carefully standardized apparatus and specimens. As a matter of fact, there is nothing like exactness with most parts produced in factories or shops. And yet the improvement resulting, as compared with the material in a so-called "natural" state is remarkable. The improvement is in uniformity of condition, strength (as represented by the elastic limit) and in toughness (as represented by per cent. reduction of area and elongation).

As with these indications of better physical qualities, so with the more important ones of resistance to fatigue (crystallization of old) and resistance to shock, to impact. A heat treated steel is a closer knitted steel; there are fewer cleavage planes, less chance of progressive fissures and rupture, and these are qualities much sought after by all users of metals carrying live loads. To be sure, there are certain grades of steel that must be handled, even commercially, with extreme accuracy in order to avoid a brittle condition from internal strains, but such steels are used only in extreme cases, and then with full realization of the danger and by men trained to the work. The results are commensurate with the risk, and qualities unknown a generation ago are obtained. Such steel should not be selected unless necessary, and when necessary a little money spent in extra care matters little.

It is just here that the designer and the metallurgist must combine their efforts and choose a metal that is a reasonable one as to price, behavior in machine shop and under heat treatment; a metal that will produce results commensurate with the cost of the finished part, all things considered, and not first cost alone, which often is a small item. The object really sought in

the purchase of materials is service or endurance. The material giving most for value received is the best, whether it be in ton mileage or in years' service. The rail that wears best for a given cost in position to use is the cheapest. This is also true with an axle, a set of gears, a set of bearings or a set of rubber tires. In fact, some of these articles are actually paid for on a mileage basis.

Sometimes it is possible to buy this excellence in the crude material; sometimes it is better to create excellence by treatment, such as the seasoning of wood, the case-hardening or simple hardening of steel. Heat treatment is another illustration. It is often wise and economical to depend on a steel of low original cost and then treat it, as in case-hardening steel. Again, it is wise to buy a steel that is used in the condition purchased, and more often it is best to combine a medium cost of material with heat treatment.

It is thought by some that if a high priced alloy steel be purchased and used as purchased, that full value is thereby obtained. This is a mistake, as there is no alloy steel that will yield anywhere near the benefit that will compensate for the increased cost, without intelligent heat treatment at some stage of its adaptation for use. An alloy steel in a natural condition, or in an annealed condition, is but little better than a good plain carbon steel. In other words, 15 cent steel is but little better than 3 cent steel, unless it be developed physically by suitable treatment, as illustrated by the following figures:

RESULTS OF TESTS IN WHITE-SOUTHER ENDURANCE MACHINE.

Mark.	Elastic Limit per sq. in.	Fibre Stress Applied.	Endurance.
.40 Carbon Steel, "As received"...	59,800 lbs.	54,800	19,300 revs.
.22 Carbon Chrome-Vanadium, "As received" (1.00% chromium)...		54,800	46,900 revs.
.25 Carbon, 3.50% Nickel-"Natural"	55,400 lbs.	54,800	75,400 revs.
.30 Carbon, 3.50% "Heat Treated".	51,100 lbs.	54,800	10,814,000 (did not fail.)

Among the same line of reasoning, steels must be chosen in relation to the design, proportions and use of any given part. If a 3 cent steel will do a piece of work, then there is no reason for the use of a more expensive steel, whether the expense be in the original cost of material or the cost of treatment. If a factor of safety of ten exists and suffices, then a material that will give a factor of twenty is of no greater value. All forms of degrees of excesses are committed in the selection of steels along these lines. The poorest steel is put to uses and the best of results expected from it, where only the best should be used. Steels are used in a natural and uncertain state when the greatest certainty should prevail, and at other times are treated when a natural condition would answer all demands. In between these extremes lies the reasonable and economical course; the hardest to follow. Theory and practice must unite; laboratory tests and empirical knowledge must be used in combination. Design and materials must go hand in hand. Extremes are necessary at times, but certainly not as a rule. With a given procedure laid out extremes in manufacture must be avoided.

It is folly to adopt a material or treatment that requires the exactness of laboratory methods. Another choice would be better, and there is always more than one way to accomplish any reasonable and practical purpose. To measure a brick with a micrometer is no more foolish than to caliper a steel ball with a pair of calipers; and to measure a furnace temperature to a degree or five degrees is as impractical as to not measure it at all with ready means for doing so at hand. Common sense temperature measurements must be possible, or the practice had best be discarded for some other. No steels are so sensitive to heat treatment as to demand very close temperature measurement. There is always a fairly wide range of safe temperatures that will produce good results, and practical and uniform results. Twenty-five to fifty degrees are close practical limits, with one hundred to three hundred degrees sometimes close enough for certain alloys. It is a sad boast to hear that a shop is controlling all temperature measurements to five degrees. It is a waste of money if true, but usually it is not true.

The alloy steels available are already many, and new ones in sight. One good movement is a search for an alloy that will produce the best of results with the widest of temperature ranges. The narrow range alloys are to be avoided as much as possible. A list of structural steels available for all classes of work:

.10 to .20	Carbon Steel.		
.20 to .30	" "		
.30 to .40	" "		
.40 to .50	" "		
.50 to .60	" "		
.70 to .90	" "		
.90 to 1.10	" "		
.20 to .30	Carbon,	with 3.50 per cent. Nickel.	
.30 to .40	"	" " " "	
.20 to .30	"	with 1.00 per cent. Nickel,	.50 per cent. Chromium.
.30 to .40	"	" " " "	" " "
.40 to .50	"	" " " "	" " "
.15 to .25	"	" 3.00 " "	1.50 " "
.25 to .35	"	" " " "	" " "
.45 to .55	"	" " " "	" " "
.15 to .25	"	with 1.00 per cent. Chromium,	.15 per cent. Vanadium.
.25 to .35	"	" " " "	" " "
.35 to .45	"	" " " "	" " "
.40 to .50	"	with 2.00 per cent. Silicon,	1.00 per cent. Manganese.

and besides these many variations of them for individual fancy or peculiar usage. All may be improved by suitable heat treatment; many should not be used until heat treated.

The dominant elements of composition have been thus briefly stated. The other elements depend upon the process of manufacture as related to a reasonable cost. With the basic open hearth, crucible and electric furnaces, all carbon steels may be obtained at a low cost containing the objectionable elements of sulphur and phosphorus below .04 per cent., or, at the most, .05 per cent. Copper, the other objectionable element, need not exceed .10 or .20 per cent. in any steel. This is a matter of selection of raw stock for melting and it would seem from experience that amounts represented by the latter figure cannot be detected as far as bad results go except possibly (not positively) in welding operations. Silicon is not objectionable and is fully under control. It costs but little to include or exclude. To keep it within narrow limits seems wise for the sake of uniformity, say from zero to .25 per cent. Manganese is also under control and should be kept uniform for the sake of uniformity. This element affects the strength and toughness and responds to heat treatment to a marked degree. It is beneficial in proper proportions.

For railroad purposes, then, there is already this long list of alloys from which to choose. The problem is to choose that which will yield the most value for money expended, whether it be carbon steel or alloy steel.

Also, whether it will pay to heat treat, and to what extent, must be considered. To do this without concrete cases before one is not possible, but the scheme may be considered in a general way:

Roadbed: Ties, tie-plates, splice-bars, frogs and switches and bridges.

Motive Power: Driving axles, tires, connecting rods, crank pins, piston rods, frames, springs and boilers.

Rolling Stock: Wheels and brakes, couplings, axles and springs.

A railroad man, in considering the choice of steels for many purposes, has before him the well kept mortality records of the system. This information is invaluable, as it is the combination of successes and failures that give the empirical knowledge that completes and perfects the understanding of theory. A record of the lifework of a piece of steel and accurate data are the most powerful tools that an engineer has to work with. The scrap heap is the most instructive place about a plant in more ways than one. Knowledge gained there by an observer, with a combination of Sherlock Holmes' and metallurgist in his make-up, is the best kind of knowledge to be used for a future guide. It is a poor observer who does not benefit by careful study of any scrap heap.

In connection with the locomotive there is much detail that can hardly be handled by any one other than a railroad man. In a general way, a few parts will be touched on, and of these one part is the driving wheel tire. It is well known that driving wheel tires are an important element in a locomotive. They are called upon to withstand severe abrasive strains while the wheel is slipping and skidding; also heat as the result of locked wheels. They are now made, as a rule, of a high carbon steel

in the neighborhood of .7 per cent. carbon. They are naturally very hard to machine even when properly annealed. To heat treat this form of steel, high in carbon as it is, would be a hazardous operation, the tendency to break during hardening being very great in sections of circular form.

It would seem that an alloy steel, when heat treated, would give a much higher elastic limit than is possible with the material now used in a forged condition, would make a better tire. It would be stronger; that is, it would not crush or pene out as easily under the rolling action. That it would abrade less under skidding and slipping conditions is doubtful, and perhaps this is the most rapid cause of rapid wear of driving wheel tires. The fine grain resulting from heat treatment would make it more difficult to sprawl off small pieces. This has been fully proved by a miniature wheel rolling on a rail; that is, a roller or ball in a bearing. It has been amply proved that a coarsely crystalline roller or ball will not stand as well as one which is very finely crystalline; practically without crystals, so fine does the fracture appear. In the best ball or roller bearing the raceway upon which the ball or roller runs is of steel which, when hardened, gives the finest possible grain, as shown by a fracture.

Within the realm of practice there seems to be no good reason why the ideal condition between driving wheel and rail should not be the same; that is, an exceedingly fine grained path upon which an equally strong and fine grained tire should roll. It is well realized that large dimensions and unfortunate sections will not permit the use of exactly the same material for tire and rail as for relatively tiny roll and raceway, but it would seem that a lesson has been learned that might well be taken advantage of as far as possible. Skidding produces so much heat as to actually draw the temper and soften a tire, which may also quickly chill again from contact with the cold metal rail. This produces the well known hard spot of the locomotive tire.

This is mentioned, as it would have a strong influence on the choice of an alloy steel that might be used for a tire and the heat treatment to which it would be subjected. It would be folly to select an alloy which would be hardened, only to have it softened again by skidding. An alloy must be selected that will produce a fine grain and high elastic limit, and retain these characteristics even up to a red heat. Just how hot the tire becomes under skidding conditions is perhaps not easily determined, but if the heat does not exceed low reds (900-1000 deg. F.) then there are alloys which, when heat treated, will not be seriously injured (weakened) by such a temperature. There is not sufficient information available from which to draw practical specifications for such a purpose, but on general principles it would seem that .40 to .50 carbon nickel, chrome-nickel, or chrome-vanadium steel might fulfill this purpose, properly heat treated.

The heat treatment should consist of a thorough refinement of grain, coupled with such drawing temperatures as would leave the material in a strong but tough condition. If certainty of strength is an important element, then the heat treated alloy is safer than the forged carbon steel ring. In the driving axle of a locomotive is found a part that might well be made of a thoroughly heat treated steel. It is of large dimensions and has to be forged with several heatings, and if left in a natural condition, it is, necessarily, in a non-homogeneous condition. Homogeneity should exist in such an important part; in fact, it should exist in any axle.

It would seem that a driving axle properly designed does not need to possess a very high elastic limit, but it does need to be in a condition to resist vibration, fatigue and impact. This means that it must be fine grained. Stiffness must be secured by large dimensions, and such dimensions as will yield the necessary stiffness will usually yield more than enough strength; but if there be certain designs where space or weight is limited, then the alloy steel may be wisely resorted to in order to obtain a high elastic limit with very greatly increased powers of resistance to fatigue.

The question of cutting and wearing of a bearing is one of lubrication and the proper combination of metals. This is well illustrated by experience in connection with the automobile crank shaft. With the pressures used, it has been demonstrated by experience that the only safe steel to put against bronze bearing boxes is one that will become—either by hardening, as tools are hardened, or by creating a surface hardness, as with case hardening—as hard as tool steel. The ordinary hardness of steel, as annealed, or as toughened by heat treatment, will not stand up against any form of brass. Cutting takes place at once (the steel seeming to cut), lost motion follows and soon becomes excessive.

On the other hand, babbit of high grade does endure indefinitely against soft steel, as used in automobiles. This experience is true under exactly the same conditions of lubrication. Therefore lubrication cuts no figure in the foregoing experience. An alloy steel, therefore, may be wisely resorted to in the crank pin of the locomotive, if greater elastic limit is needed, or greater homogeneity be an important factor.

The connecting rod is another illustration of a portion of the locomotive that must be forged, and after forging naturally cannot be in a homogeneous condition. It should, therefore, receive some treatment after forging, either annealing or heat treating, the latter to be preferred, because of the greater strength obtained. The locomotive crank pin, like the axle, may be of such generous design, in order to get sufficient bearing surface, as to possess surplus strength. This being the case, there is no need of resorting to an alloy steel At the same time, it must be borne in mind that a crank pin forged from an alloy steel of the proper composition, and properly heat treated, is, without question, much more reliable than steel in any other condition.

If a connecting rod must be stiff, to withstand the "whip" of rapid reciprocating movement, possibly the design demands so much material that strength is not an important consideration. Under such condition, alloy steel is not necessary. On the other hand, if fatigue due to vibration be an important factor, then the fine grain of an alloy steel resulting from heat treatment becomes important. The piston rod is a part to which the remarks on connecting rods also apply; possibly to a less extent as to severe punishment. There is no question but what the piston rods should be made of homogeneous material, and therefore bettered by heat treatment. The problem is to ascertain whether or not a material of very high elastic limit is necessary.

The frame of a locomotive presents very different problems. It seems as if an easily forged, easily welded steel would be a most important consideration. If an alloy steel is chosen, it must be with these qualities in mind. The shape of the frame is irregular and will not permit easy handling for heat treatment. Annealing after forging is certainly desirable in order to bring the frame into a homogeneous condition with uniform grain throughout. That the sharp angles would withstand heat treatment is a question. If the treatment be a practical operation, the resulting benefit cannot be questioned. This problem is not unlike that encountered in the automobile frame, which is very thin, consequently, very sensitive to heat treatment. It is irregular in shape and difficult to handle. Nevertheless, heat treatment is carried on in a commercial way and with success. The most reliable frames and the strongest frames to-day are those of heat treated alloy steel. As far as locomotive frames are concerned, it is a question whether or not the benefits received warrant the extra cost of the material and the cost of heat treatment.

Springs, whether for locomotive or car, whether leaf spring or helical spring, are important. Exact knowledge of materials and treatment may exist, but it has not yet been put into practice in a widespread manner. Until the advent of the automobile, the manufacturer of springs followed along in the old ruts, almost undisturbed. His methods were good enough for the wagon and pleasure vehicle, and apparently good enough for railroad construction; otherwise, a railroad engineer would have stirred up just as much agitation as the automobile engineer has.

There was but one grade of spring material in common use; a carbon steel varying from .75 to 1.10 per cent. carbon, or thereabouts. The lower carbons within this range were used

for relatively light springs, and the higher carbons for the heavier springs. For the automobile other steels were suggested; possibly because it was found the European manufacturer used them.

Silicon steel, containing 2 per cent., more or less, silicon and .50 per cent. manganese, was found in many springs. This quality is sometimes referred to as "Silico-Manganese" steel, seemingly almost without warrant, as the manganese contained in much of it is no higher than the manganese contained in low carbon structural steel, for example. Carbon-chrome-tungsten steels are also used, as well as chrome-nickel-tungsten-vanadium and chrome-vanadium steels.

All of these steels when heat treated show an elastic limit very much higher than is possible to obtain with carbon steel, and at the same time retain a sufficient degree of toughness. The alloy steels easily yield an elastic limit of 200,000 lbs. per square inch, with a fine grain and a great degree of toughness. This elastic limit is obtainable with an alloy after drawing back at a temperature of 800 deg. F.; whereas a drawing temperature beyond 500 deg. F. or 600 deg. F., with carbon steel, lowers the elastic limit too much and gives a spring that is too soft, thereby causing it to set while in use. To be sure, the best has not yet been brought out of carbon spring steel, and will not be until improved methods as to uniformity obtain. An alloy steel turned over to the spring maker of the old school will certainly not make springs uniform in quality nor uniformly superior.

Springs are subjected to continuous alternate stress, and a fine grain is essential to a long life. Fine grain exists to a higher degree in the alloy steel than in the carbon steel, all other things being equal. Here, then, is an instance in railroad construction where alloy steel may be used to great advantage.

To use alloy steel in a boiler means practically, as far as can be seen at this time, that the steel would be used in a rolled or annealed condition, for the simple reason that the heat treatment of a boiler plate does not look like a practical operation at this time. Assuming the steel to be used in an annealed condition, then the improvement in elastic limit would be relatively small, and probably not great enough to warrant the extra expense. There would be some additional trouble in punching, reaming and drilling, and some additional power used in bending and forming.

Apparently, there is little to be gained from the use of alloy steel in the locomotive boiler. If there be a good opportunity, it must be in the stays and staybolts. These parts are subject to alternate stress. A tough alloy steel, treated to give the utmost toughness, ought to possess such characteristics as would endure under boiler conditions. A staybolt should be treated after threading. If treated before, then the fiber, or arrangement of grain, is disturbed by the threading—it is interrupted—and the bolt resembles a nicked bar, and is therefore more easily broken. If treated after threading, there is no serious disturbance or interruption in the continuity of the grain.

In car building the wheels are of much importance. With modern rolling processes a wheel may be made of any good forging steel. So far, it does not appear that they are heat treated commercially, nor that the use of alloy steels has been widely adapted. It does not appear that the industry demands a better wheel than that made from ordinary steel properly forged; but this is not saying that an alloy steel wheel, properly heat treated, would not be better. Consequently, with increased demands, it does not seem out of the realm of possibility that heat treated alloy steel wheels may become a commercial proposition.

As to car axles—as far as one may judge from the continuity of a given design that has endured for the last generation, it appears that there can be no great difficulty about the endurance of car axles. It is fairly good proof that the design and material satisfy the need. Many years ago Coffin brought forward the heat treated axle for cars and it certainly was an improvement. If the necessity arises, the heat treated alloy will be an improvement many-fold greater, but there is no necessity for using an alloy steel unless there be compensating benefit. That all car axles should be heat treated, it does not appear can be questioned at this time. Without such treatment the grain is coarse and fatigue rapid; with treatment the grain is fine and fatigue slow.

As already briefly stated, it is clear that the subject covered by the foregoing cannot be covered as well by one not directly connected with railroad engineering as by one who is. It may be that the outsider will look at the problem from a new and different angle; or, to put it another way, that the fool will rush in where angels fail to tread. If any new thought has been excited that may be followed up and lead to something really good; therein lies the excuse for what has been written.

DOUBLE TRACK MILEAGE

The proposal of the Harriman Lines to spend a vast amount of capital in double tracking their system, calls attention to the fact that there is a much smaller percentage of double track road in this country than is generally supposed. People who ride on the double and quadruple track lines in the Eastern part of the country are often unaware that more than two-thirds of the mileage of the country is single track. This statement includes 80,000 miles of siding.

Late returns of railway mileage shows that there is a total trackage in this country of 326,000 miles, of which 80,669 miles are sidings. There is 221,132 miles of single track and 20,637 miles of double track, 2,186 miles of treble track and 1,491 miles of quadruple track. Mr. Slason Thompson makes the following summary of track mileage covering the period since 1907:

Year.	Single Track.	Second Track.	Third Track.	Fourth Track.	Yard Track & Sid.	Tot. Mi. Oper. All Tracks.
1909 (94.4%) Bureau.	221,132	20,637	2,186	1,491	80,669	326,115
1908 official..........	230,494	20,209	2,081	1,409	79,452	333,646
1907..................	227,455	19,421	1,960	1,390	77,749	327,935
1906..................	222,340	17,396	1,766	1,279	73,760	317,083
1905..................	216,973	17,056	1,609	1,215	69,941	306,796
1904..................	212,243	15,824	1,467	1,046	66,492	297,073
1903..................	205,313	15,681	1,303	963	61,560	283,821
1902..................	200,154	13,720	1,204	895	58,220	274,195
1901..................	195,561	12,845	1,153	876	54,914	265,352
1900..................	192,556	12,151	1,094	829	52,153	258,784
1899..................	187,543	11,546	1,047	790	49,223	250,142
1898..................	184,648	11,293	1,009	793	47,589	245,333
1897..................	183,284	11,018	995	780	45,934	242,013

The table shows that where there has been an increase of only 50,798 miles of single track, or 27.7 per cent., in twelve years, all trackage has increased over 98,000, or 42 per cent., during the same period. It also shows that during the same twelve years second track has increased 87 per cent.; third track 120 per cent.; fourth track 91 per cent., and yard track and sidings 76 per cent.

LOCOMOTIVE SMOKE PREVENTION

In connection with the exhaustive inquiry into smoke prevention in the city of Chicago, as presented by Paul P. Bird in a paper before the Western Society of Engineers on February 15, the author makes the following timely observations on the proportion which the smoke emitted from locomotives bears to the general nuisance:

"Locomotive smoke carries with it quantities of sparks and cinders, while in stationary plants relatively little of such material is thrown out. This is because of inherent features in the design that are unavoidable. On a locomotive there is so little room available that the grate surface of the boiler is necessarily small and consequently a powerful draft is necessary to do the required work. This draft is obtained by discharging the exhaust steam from the engine cylinders up the stack. Because of this strong draft great quantities of fine coal and ash is drawn out of the firebox with the smoke, which in turn are discharged from the stack in the form of cinders. From 8 to 18 per cent. of all bituminous coal put into locomotive fireboxes escapes from the stack in this manner. In Chicago about 5,600 tons of coal are burned in locomotives each day. Assuming that 10 per cent. of the coal leaves the stack in the form of cinders, it means that 560 tons of cinders are thrown into the air and dropped on the city of Chicago every day. This is equal to about 14 carloads.

"On the other hand, in stationary plants where there is plenty of room for a larger grate surface and where the coal is burned with a lower draft and with tall chimneys, but few cinders are carried out with the smoke. Therefore the smoke from locomotives on account of carrying with it sparks and cinders is far more objectionable than the smoke from stationary plants, and as it is discharged into the atmosphere at no great distance from the ground and is trailed over long courses, it is safe to say that from the standpoint of a nuisance the steam locomotive is the worst offender of all. The investigation shows that the locomotives of Chicago make about 43 per cent. of the total smoke. Considering its character, the conclusion seems warranted that steam locomotives produce over one-half of the dirt traceable to smoke.

"The lowest percentage of smoke density made by the locomotives of any railway was 10.7 per cent. Probably 10 per cent. is as low an average as can be maintained with steam locomotives using soft coal. Therefore the very best condition that can be hoped for in Chicago is to have all locomotives average 10 per cent. density, which would mean that the locomotive smoke would still be 29 per cent. of the total, and probably be responsible for over one-third of the dirt. The modern steam locomotive is such a highly developed machine that it is extremely unlikely that any change will ever be made in its construction which will produce better results than this. A further reduction of the smoke made by locomotives can only be brought about by change of fuel. The possible fuels besides the local soft coals are semi-bituminous coal, anthracite coal, coke and oil. A considerable amount of semi-bituminous or Pocahontas coal is now being burned by some of the railways in Chicago, and although it makes less smoke than Illinois coal under the same conditions, its use by no means guarantees the entire elimination of smoke. Probably the universal use of semi-bituminous coal would not succeed in reducing the average density of smoke below a point that is considered possible with Illinois coal.

"The general use of anthracite coal or of coke for locomotives would eliminate smoke, but the other nuisances due to steam locomotives would not be diminished. If coke were used there would be an increase in the quantity of sparks and cinders discharged from the stacks. In either case the volume of furnace gases and their effect in vitiating the atmosphere would not be reduced. Fuel oil makes smoke unless carefully handled, and the smoke that is made is more objectionable than the smoke from soft coal. It is probable that if all locomotives in the city burned oil, the smoke and gases would form more of a nuisance than the soft coal smoke of to-day. The general use of any specially selected fuel would greatly increase the cost of fuel to the railways, and the practical difficulties involved would make it a very difficult thing to bring about. The locomotive fireboxes would have to be changed if coke or hard coal were used. In order to insure that all locomotives operating in the city limits used the same fuel, all the engines on an entire division would have to be thus equipped, which of course would greatly increase the cost of operation."

It is suggested by the author that general electrification within the city limits offers the only final and satisfactory solution for the smoke problem, and this, of course, is obvious, but in view of the fact that the locomotive contribution appears to be, from Mr. Bird's deductions, but 43 per cent. of the total, it would hardly appear as fully consistent to assume an expense in Chicago of some $30,000,000 with the knowledge that only one-half of the nuisance will be abated. The above quoted portion of the paper, however, is of exceeding interest in its comparison between the gravity of the objectionable features as contrasted between locomotives and stationary plants.

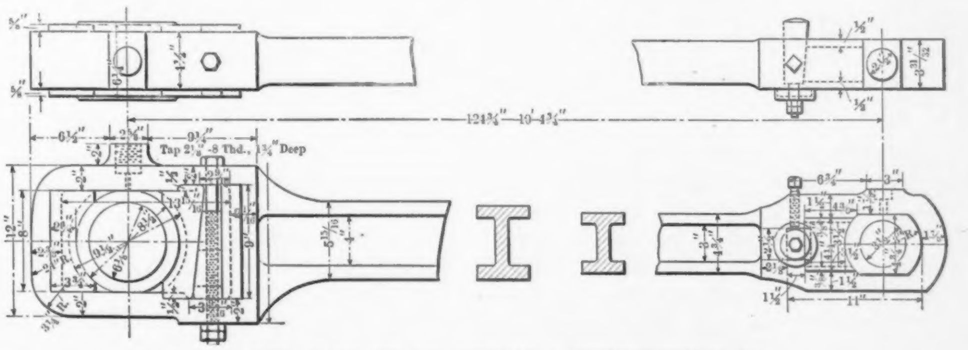
Experience has shown, and it cannot be denied that a small portion of smokeless fuel placed ahead on the tender, to be used while within the city limits, affords the most economical if not a fully satisfactory solution to the problem, as far as road engines are concerned. It is a question indeed whether it is really as grave as pictured, but at all events, as has been said before, it should not entail the heavy burden of electrification on railroads for the purpose of smoke prevention alone.

MAIN ROD WITHOUT STRAPS OR BOLTS

To guard against the liability to serious accident which is always present in the instance of broken straps, or even keys and bolts, the Chicago and Northwestern Ry. is experimenting with a new design main rod, in which through an ingenious and decidedly practical arrangement these familiar parts have been effectually dispensed with. The new rod on which patent has been applied for by C. Markel, a shop foreman on that road, is being tried out on a modern freight engine in hard service. It is said to be entirely satisfactory, and in particular from the standpoint of maintenance.

The details of its construction are shown in the accompanying drawing. It will be noted that steel filling blocks are used in the back end. These are fitted to the opening in the rod, and are bored to fit the two half circle pieces of brass. These latter are turned up on a mandrel and are simply planed top and bottom to keep them from turning in the rod. On account of being practically all lathe work the brass is simple and cheap to make. It has no flanges to break, which is a common occurrence on those of the usual design, and on many roads the cause of a very large number of renewals.

The arrangement under consideration is made to hold the liners in place by one inch flanges on the steel filling blocks. The latter, and in fact, all parts of this rod, are made to jigs and are interchangeable. A special chuck is used to hold the filling blocks while being bored out, and also a special mandrel to hold the bushings while being turned to diameter.



SOLID END MAIN ROD ON CHICAGO & NORTHWESTERN RY.

The front end brass to this rod is also turned, instead of the usual planed and hand fit brass. The brasses are finished for stock, with the exception of the bore for the pin fit, which implies very quick and cheap repairs in comparison with the cost of renewing these parts in the main rod of ordinary design.